PANAMA OR NICARAGUA—WHICH?

SCIENTIFIC AMERICAN

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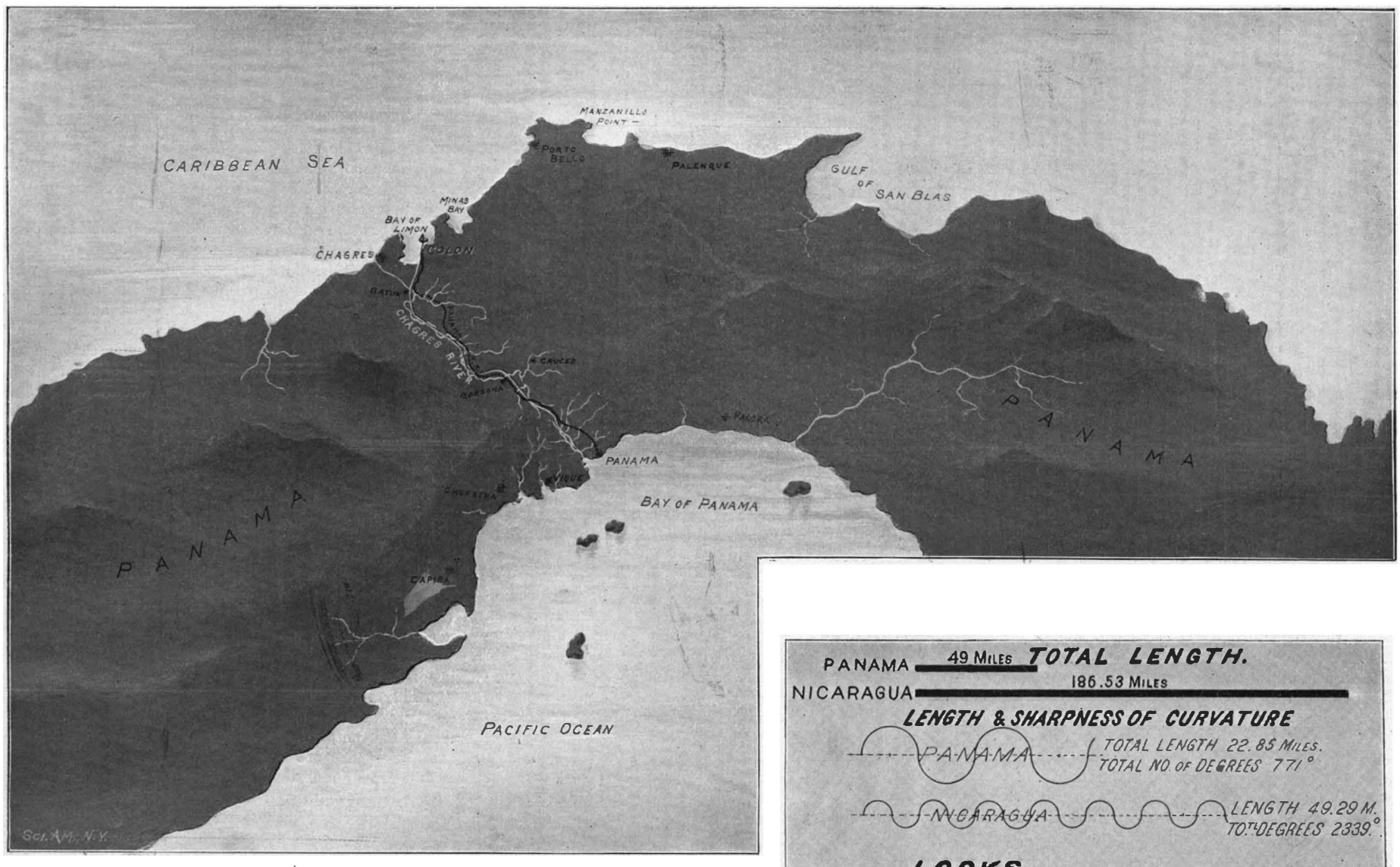
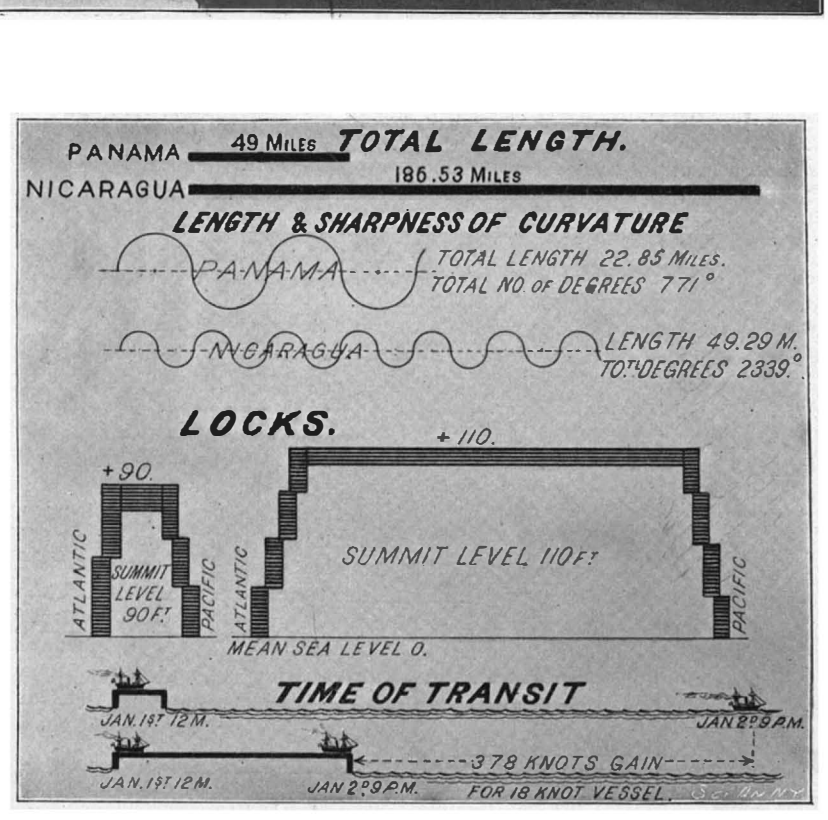
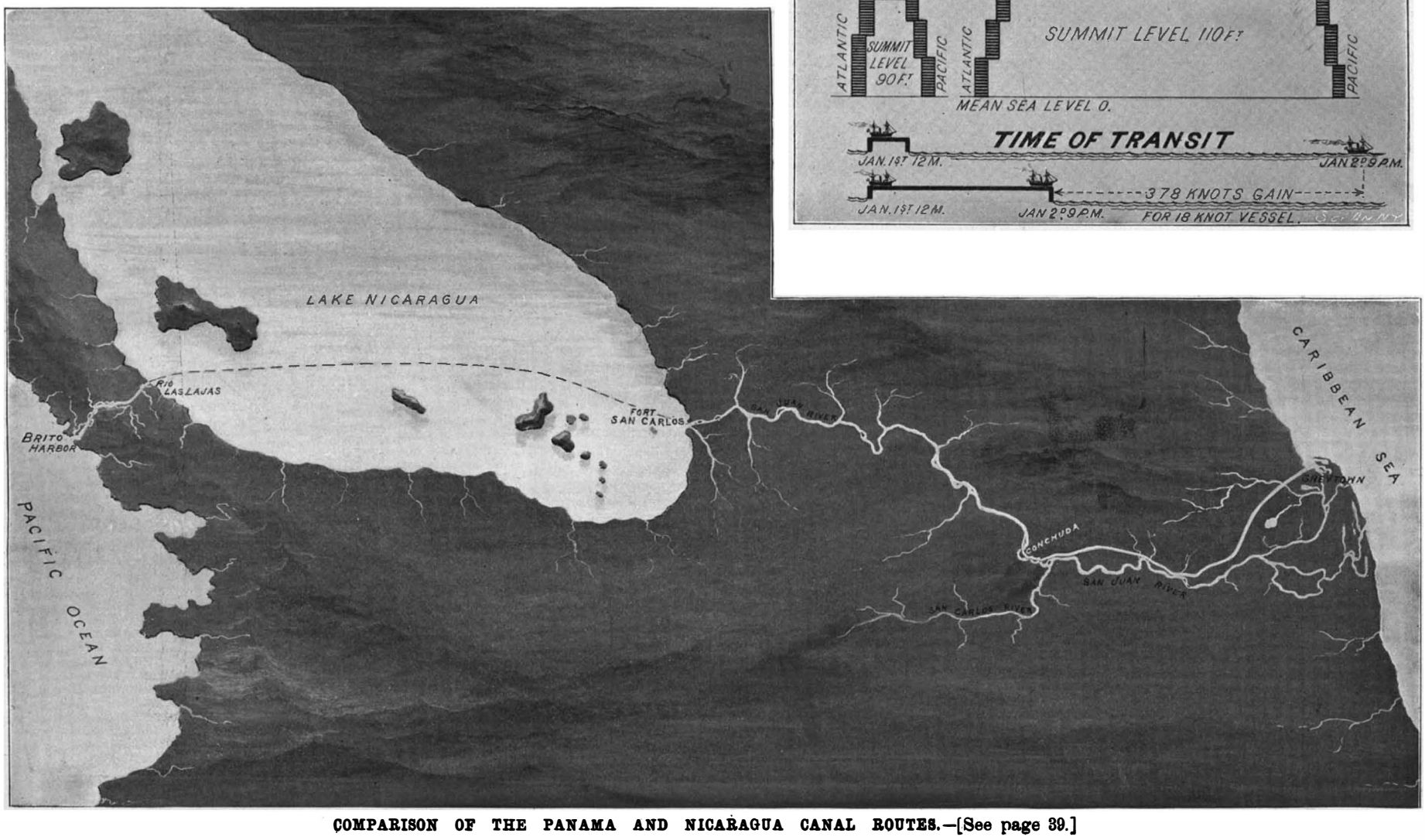
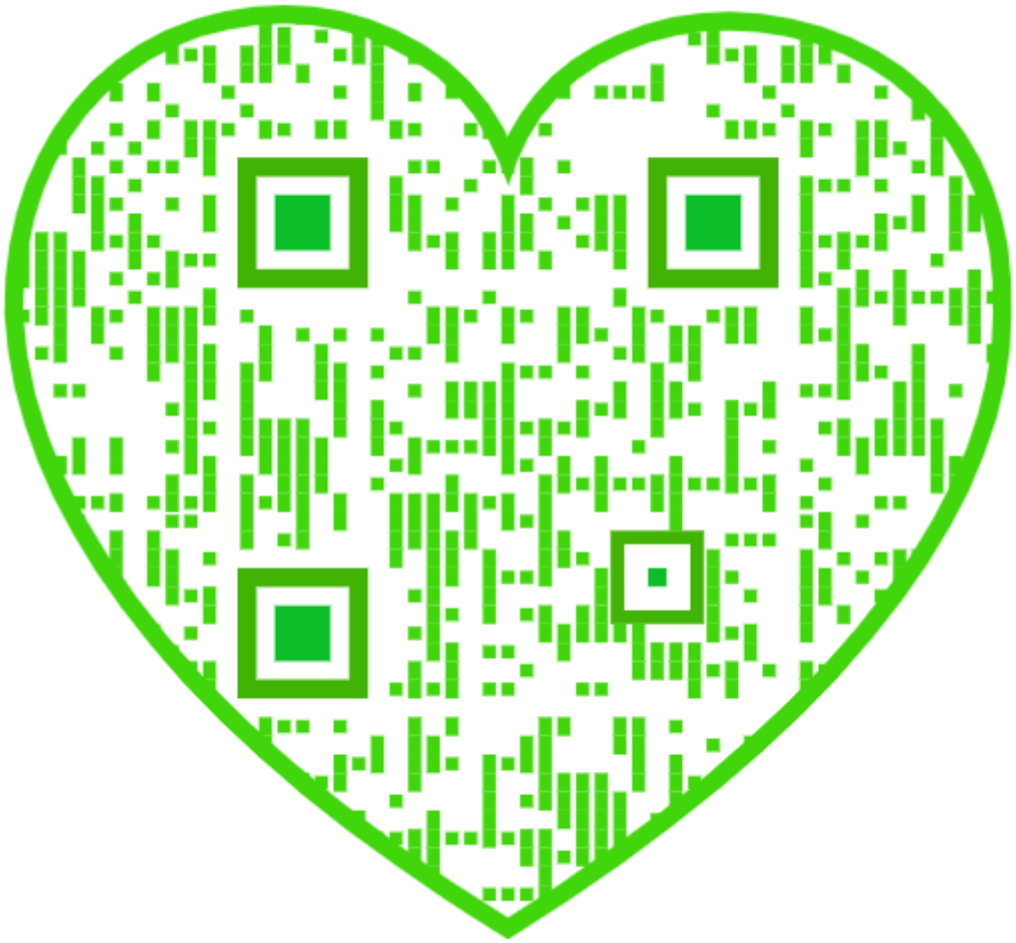


Panama Canal—Length, 49 Miles. Time of Transit, 11 Hours 14 Minutes.





COMPARISON OF THE PANAMA AND NICARAGUA CANAL ROUTES.—[See page 39.]



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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE ISTHMIAN CANAL—HISTORICAL.

NICARAGUA.—The first actual survey for a canal at Nicaragua was made by an American, Col. A. W. Childs, in 1850 to 1852 The project as outlined by him has been the basis for all subsequent locations; the route selected in his survey differing indeed but very little from that which is now recommended by the Isthmian Canal Commission. Childs recommended a summit level, in which was included Lake Nicaragua, 108 feet above sea level, this level to be reached by twelve locks on the eastern side and thirteen locks on the western side. The canal was to have a depth of 17 feet and a bottom width of 50 feet, and the total cost was to be $31,538,319. Then followed a survey in 1872 under Commander E. P. Lull, U. S. N., in which the lake was to be held at a minimum summit level of 107 feet, reached by eleven locks on the western and by ten locks on the eastern side of the summit. The depth of the canal was to be 36 feet and the cost was estimated at $65,722,137. Eleven years later another survey was made, this time by A. G. Menocal, Civil Engineer, U. S. N., the object of the survey being the relocation of the Lull survey with a view to cheapening the cost. The principal changes consisted of the creation of a summit level, which extended from a dam in the river west of Lake Nicaragua to a dam some 65 miles down the San Juan River from the lake. The canal was to leave the San Juan just above this dam and be carried by a short cut through the hills to the Caribbean Sea. The Maritime Canal Company was formed in 1889 to construct a canal on the lines of the Menocal survey. The total estimate for this canal with a 28-foot depth of water was $67,000,000. After doing more or less work the Maritime Company ceased operations in 1893 for lack of funds. In 1895 Congress appointed the Ludlow Commission to examine and report on the Maritime Canal Company's project. This Commission reported that the difficulties of building the canal had been underestimated; and they submitted an estimate of their own which placed the cost of completion at $133,472,893. At the same time the Board suggested a more thorough examination of the locality. In response to this recommendation the Admiral Walker Commission was appointed; and in due course it reported that the canal would cost a maximum sum of $140,000,000. It was about this time that the government awoke tardily to the realization of the fact that the canal question was a wider one than that of Nicaragua alone, and a new board, known as the Isthmian Canal Commission, was appointed to investigate every possible route across the Isthmus and definitely determine which was the best. A digest of this report will be found elsewhere in this issue, and in more extended form in the current issue of the SUPPLEMENT.

PANAMA.—It will be a surprise to many who believe that American interests are necessarily and exclusively identified with Nicaragua to know that the Panama route was surveyed by Commander Lull in 1875, that he recommended the construction of a 26-foot canal with a summit level of 124 feet above mean tide level, and that this route was located very much on the same route as that adopted by the present Isthmian Canal Commission. He estimated the cost of this canal at $94,511,360. In 1879 an International Congress met in Paris and recommended the building of a sea-level canal from Colon on the Atlantic to Panama on the Pacific, the work to be completed in twelve years at a cost of $240,000,000. Work was begun in 1881. An enormous amount of plant was purchased, 15,000 laborers were imported, and with the most incomplete data to work upon, the De Lesseps people rushed into the most stupendous engineering undertaking of the age. Yellow fever, floods, incompetence, unparalleled fraud and dishonesty, coupled with the impossible nature of the undertaking itself, soon brought about the inevitable disaster, and in 1889 a receiver was appointed, who found that securities to the amount of $435,000,000 had been issued and $246,000,000 had been squandered. In 1894 a new company was formed for the purpose of completing the canal. They determined to abandon the scheme for a tide-level canal and, instead, adopted a plan for a canal 29½ feet deep with a summit level of 97 feet, a second level of 68 feet and a third of 33 feet above the sea. The Chagres River was to be controlled by means of a dam at Bohio, forming a navigable lake in the valley of the Chagres, and another dam further up the Chagres River, which was to supply water to the summit level. An International Technical Commission of Engineers examined the plans of the new company and pronounced them perfectly feasible, the estimated cost of completing the canal being set down at $102,400,000. Our own Isthmian Canal Commission propose a 35-foot canal, with a 90-foot summit level and three locks, which they estimate can be built for $144,233,358. The latest step of importance connected with the canal has been the offer of the Panama Company to sell its property for the sum of $40,000,000.

THE CANAL FROM THE ENGINEERING STANDPOINT.

The report of the Isthmian Canal Commission has swept away from the whole canal question a mass of misconceptions and misstatements with which it has been hitherto clouded. After a careful perusal of the report one is impressed with the conviction that the physical obstacles to the construction of a canal either at Nicaragua or Panama have been mastered; that the uncertainties have in a large measure disappeared; and that, judged from the standpoint of construction and subsequent maintenance and operation, Panama offers decidedly the better route.

1. In the first place, the Panama region is much better known and understood; the observations extend over a longer period; the surveys have been considerably more elaborate and complete; the climatic conditions are better known; and work having been opened up along the whole route and prosecuted with more or less energy for twenty years, the nature of the soil, its action when exposed to the weather, and in the process of handling is, by this time, well understood.

2. At Panama there is a well-built railroad throughout the whole length of the canal, terminating on each ocean in a good harbor with ample wharf and dockage facilities. Should the United States determine to build this canal, contractors could go down and commence work at once, for good housing accommodation is already on the ground for an army of from 15,000 to 20,000 laborers. At Nicaragua, on the other hand, entirely two new harbors would have to be created, at a cost of $3,750,000, and 100 miles of double-track railroad would have to be constructed at a total cost of $7,575,000. In fact, two years' time and $11,000,000 of money must be expended before the actual construction of the canal itself could be commenced on any adequate scale.

3. At Nicaragua the work would be spread out over 183 miles of distance, whereas at Panama it would be concentrated within a distance of 49 miles—a fact which would conduce greatly to facility and economy of construction.

4. At Panama the plan of control of the flood waters and of maintenance of the summit level is very much simpler than at Nicaragua. At Nicaragua a 3,000-square-mile lake and 60 miles of canalized river have to be maintained at a predetermined level, alike in periods of drought and heavy rainfall; while a flow of 200,000 feet per second of water has to be controlled in the San Juan and San Carlos Rivers. At Panama, on the other hand, the problem involves the control of a single river, with a maximum flow of 75,000 cubic feet per second, and by the erection of a single dam the flood waters of this river are conserved in a summit lake, the conditions of whose regulation are accurately determined. At Panama the problem is relatively far less stupendous, and the engineering and general hydraulic data are better known.

5. At Nicaragua there is a 110-foot summit and seven different levels, involving the construction and operation of eight widely separated locks, whereas at Panama there are but two levels and three sets of locks, and the summit level is 20 feet lower.

6. The total length of the Nicaragua Canal is nearly four times that at Panama, and the time of transit is longer by about 22 hours, the respective periods being 33 hours for Nicaragua and 11 hours 14 minutes for Panama, and although this difference is offset in the case of voyages between certain ports by the fact that the distance from port to port by Nicaragua is less than it is by Panama, it must be remembered that a ship when sailing in deep water is undergoing fewer risks than when she is navigating a tortuous and shallow artificial canal.

7. The risks of operation are considerably less at Panama, for the reason that vessels will spend far less time within what might be called the "danger zone," this last being that portion of the canal which is above tide level. The danger zone at Nicaragua will be 176 miles in length; at Panama, on the other hand, it will extend for only 23½ miles. This is a most important consideration for vessels of the merchant marine, and it has an even more important bearing upon the interests of the navy.

8. Finally, while the time for the completion of the two canals is the same, the cost of Nicaragua, now that the Panama Company has offered to sell its properties for $40,000,000, is $5,630,700 greater. To this must be added the fact that a canal at Nicaragua would cost $1,300,000 more every year to maintain and operate.

THE CANAL FROM THE STANDPOINT OF COMMON SENSE.

The great Isthmian Canal problem has reached a stage at which it needs only the exercise of a little common sense for its satisfactory solution. The question of the proper location for the canal is first and last one of engineering. In considering it, the American people should remember that whatever of sentiment, whatever of prejudice, whatever of so-called patriotism or national prestige has been allowed to entangle itself in this question, ought to be entirely swept away, and the problem looked into, weighed, judged and a final decision reached purely on the physical and engineering facts as they have been determined by our government engineers and presented to the American people for their decision in the recent most able, comprehensive and easily understood report.

We have no hesitation in saying that if anyone who is interested in the Isthmian Canal problem will read the digests and analysis of this report as presented in the current issues of the SCIENTIFIC AMERICAN and SUPPLEMENT, he will come to the conclusion that judged on the grounds of practicability of construction, security, permanence, convenience and ease of operation, and cheapness of first cost and maintenance, the Panama Canal as designed by our engineers is by far the better scheme. Having said this one has said all; but if it be suggested, as has lately been frequently done, that Nicaragua has exclusive claim upon our national interest and sympathy, it must be replied that the first complete survey at Panama was made, as we have shown elsewhere, by an American naval officer for the American government, and that over half a century ago this country concluded a treaty with New Granada (now the United States of Colombia) guaranteeing the perfect neutrality of the Isthmus at Panama as a highway from the Atlantic to the Pacific. The solemn stipulations of that treaty have remained in force ever since, and only within the last few months our government, acting under the stipulations of this treaty, landed troops for the protection of the Panama Railroad.

Congress has grown so used to considering Panama as a French undertaking, that it is only now beginning to realize that if we take hold of the Panama scheme under our own terms of purchase, it becomes as truly an American enterprise as would the construction *de novo* of a canal at Nicaragua.

Although the Hepburn Canal Bill has been passed in the House by a practically unanimous vote, it is significant that an amendment authorizing the President to negotiate for the Panama as well as the Nicaragua route was lost by 102 votes to 170. This result would indicate that if the Senate should send the bill back to the House, amended so as to provide for building the canal on the Panama route, the House would accept the revision.

THE NEW YORK CENTRAL TUNNEL TRAGEDY.

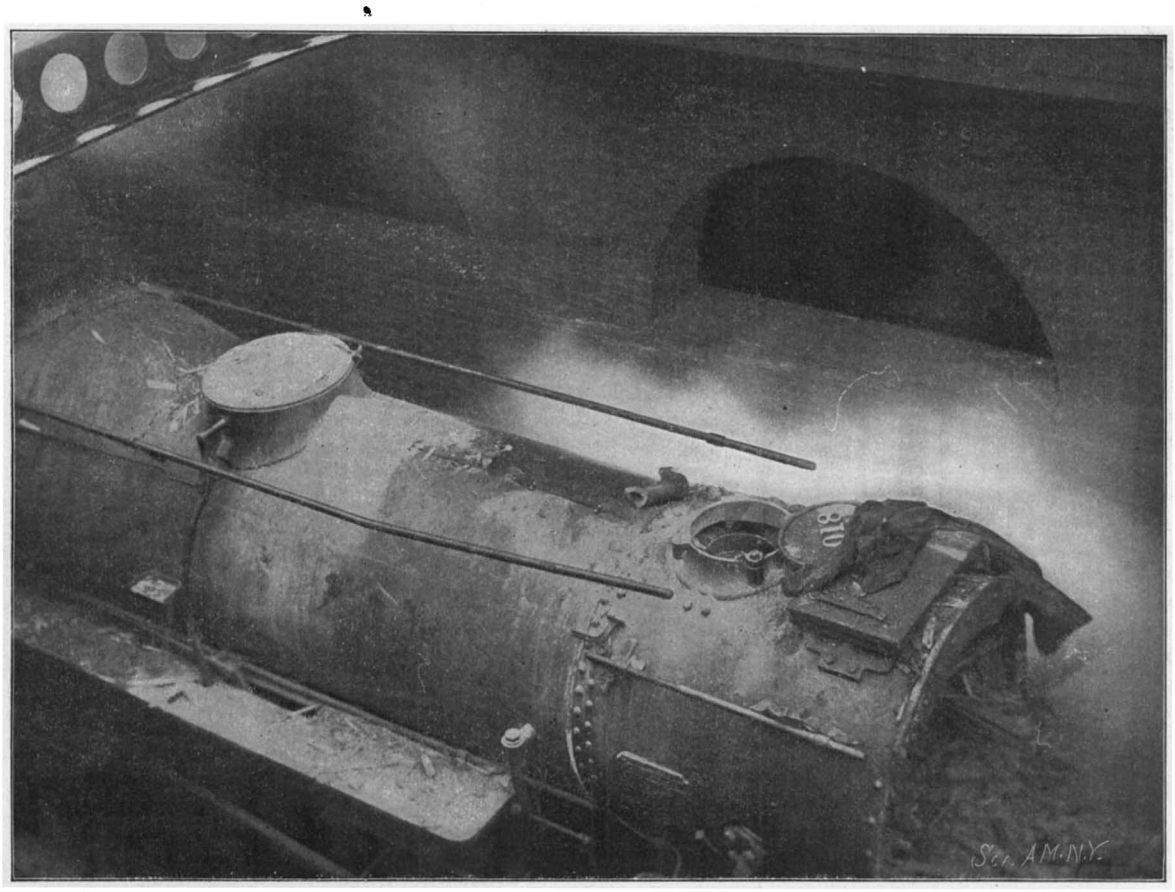
The Park Avenue four-track tunnel of the New York Central and Hudson River Railroad is altogether unique among the celebrated tunnels of the world. It brings the traffic of two of the greatest railroad systems in America into the most crowded station yard and station in existence. The multiplied traffic of the New York Central, the Harlem and the New Haven Railroads converges to this tunnel at its northern end, where the ten tracks of these three systems unite in four tracks, and the accumulated traffic, acting like flood waters suddenly confined within a narrow channel, literally surges and struggles—we had almost said eddies—stopping, starting, crowding train upon train, until it is liberated at the southern end of the tunnel, and spreads out again like liberated flood waters onto the many tracks of the yard and terminal station. In view of the fact that the smoke and steam and dust of the many trains that rush through render the visibility of signals at the best of times somewhat uncertain, the dictates of prudence and safety would suggest that the whole length of this tunnel, about a mile and three-quarters, be treated as a complete block in the automatic block signal system of the road, no two trains being allowed on the same track within the tunnel at the same time. This course, however, though eminently safe, would be quite fatal to that dispatch in handling the traffic which the traveling public is ever demanding of the railroads that run into this station. Consequently the railway company has divided the tunnel itself into signal blocks with distance and home signals, and by using the best-known automatic devices, has endeavored to effect a compromise between safety and dispatch, sacrificing something of the

former to gain somewhat of the latter. Under the system adopted, it is a daily occurrence for crowded passenger trains to be stopped at the southern end of the tunnel under atmospheric conditions which render the visibility of the signals by a following train very uncertain.

Thanks to the eternal vigilance of the train hands, the impending and ever-present disaster, to the possibilities of which the public have been always keenly alive since the distressing tunnel accident in 1891, has been staved off for a whole decade—but it has come at last, and in truly heartrending magnitude and horror. Fifteen lost and twice as many seriously injured, are the results of a rear collision, which occurred under just such a conjunction of circumstances as everybody has feared. A crowded local train was stopped by signal before it was clear of the tunnel at the Forty-second Street end. Another local on the same track, whose engineer was endeavoring to maintain his credit with the company by making up lost time, was following as closely behind as the signals would allow. The engineer runs past the green signal which is set against him, and is holding his train at a speed which he judges consistent with his ability to stop at the red signal, when the red signal flashes out ahead, and with too much impetus to stop, he runs by it, over the torpedo set to warn him, past the rear flagman, and crashes into the ill-fated train.

As we go to press it is too early to say definitely where the blame should be placed. It is rumored that the engineer did not see the signals; but his fireman affirms that he saw both the green and red signals and notified the engineer accordingly as each was passed. The measure of accountability of the company will be determined by the question as to whether they have used every effort to minimize the great risks which undoubtedly exist at present. This statement suggests at once the question of abolishing the steam locomotive and substituting electric traction between Harlem and Forty-second Street. There is not the slightest doubt that electrifying the system would reduce the dangers of tunnel travel very materially. Signals would be much more clearly visible and audible signals more distinctly heard, while the brake-control of the trains would be somewhat increased. We would suggest, moreover, that there is room for an extra tunnel on each side of the present structure. If these were built, as was suggested, for the use of the Rapid Transit tunnel during some of the earlier discussions of the Rapid Transit route, the density of travel through the tunnel would be reduced fifty per cent. With electric traction installed, the objections to the construction of additional tunnels would be removed. Moreover, in granting the franchise to the New York Central for their construction, the city would have an opportunity to gather in some adequate recompense for the enormously valuable franchises that were practically given away to this system at an earlier day.

The accompanying photograph of the wrecked engine tells its own story. It crushed through the rear wall of the last car and embedded itself up to the cab windows within the car, while the remaining momentum of the engine was sufficient to telescope the forward half of the car into the car ahead, the unfortunate victims being literally ground between the nether and the upper millstone. The roof of the car stripped smokestack, bell and sandbox from the locomotive, burst in the smokebox door, and allowed the smokebox to become filled with wreckage and sawdust as shown in our illustration.



THE WRECKED NEW YORK CENTRAL ENGINE, AFTER IT HAD BACKED OUT OF THE NEW HAVEN PASSENGER CAR.

THE PERFECTING OF THE GASOLINE MOTOR.

The light high-speed type of gasoline motor, the invention of the Frenchman, Bouton, was a long stride forward toward developing and making more generally useful this ever-ready and instantaneously available form of power. Heretofore, gasoline motors were ponderous and clumsy, and were suitable only for stationary purposes, or for staunch, well-built launches and small boats. Their uncertainty of operation caused them to be viewed with disfavor and to be rarely used for business purposes.

In looking about for a suitable power for a motor machine, gasoline at once suggested itself to the above-named French engineer. He had had experience in the building of steam engines; and, after interesting Count De Dion in his project, began experimenting in 1881 with a gasoline motor he had designed for a tricycle. His motor had necessarily to be as light as possible in order to be used on so light a machine. Consequently, he designed it to run at a high rate of speed, which allowed of the parts being smaller and lighter than those formerly employed. The mechanism was simplified as much as possible by recourse to the high tension or jump spark system of ignition—a system that had been tried by Lenoir in the early days of gas engine invention and given up on account of the then apparently insuperable difficulty of maintaining the insulation of the sparking plug. By this method of ignition, the mechanical igniter with movable parts was dispensed with, and all necessary adjustments could readily be made outside of the cylinder. By a suitable apparatus for varying the time of the make and break of the primary circuit, the spark could be made to occur in the cylinder within a wide range of time, and thus the speed of the motor could be regulated with the greatest ease. The breaking down of the insulation of the sparking plug was largely avoided by adopting a vertical type of motor and employing splash lubrication. By placing a certain quantity of oil in the crank case, it was found that the motor would be lubricated thoroughly in every part without the oil getting on the plug, which was placed in a chamber at one side of the cylinder. In this chamber was situated also the inlet and exhaust valves. The former was opened by the suction of the motor, which left only the exhaust valve to be mechanically operated. After many experiments and practical experiences, an atomizing form of carbureter was adopted for supplying the motor with gas. At first the plan of cooling the motor by the air circulation caused by the progress of the vehicle was adopted, but this was found to work satisfactorily only with very small motors and in cold weather. In summer a tricycle equipped with such a motor would run only a few miles before the motor would rapidly fall off in power and soon cease to operate. This was ascertained to be due to the excessive heat of the cylinder head causing the incoming charge to expand before it could enter the cylinder. Water-jacketing was, therefore, found necessary to keep the head cool, and while in the De Dion-Bouton motor the whole cylinder is cooled by water, an American inventor has found that by cooling the head alone equally good results are obtained. The water is usually cooled by being pumped through flanged radiating coils. It has to be renewed once in a while, as it is gradually evaporated. A French inventor has recently made a radiator of copper tubes connected with the water jacket and hermetically sealed. The water is allowed to boil and to reach a pressure of two atmospheres, but is condensed again in the radiator. No water is lost and hence the care of replenishing it at intervals is avoided, while the temperature of the cylinder and head, even under the most adverse conditions, cannot exceed about 260 deg. F.

While all the other problems of the light gasoline motor have, therefore, practically been solved, the ignition problem still remains to give trouble. Electric ignition of any kind requires more or less attention, whether it is of the contact or jump spark type, and either batteries or dynamos are necessary to furnish the electric current. These are liable to be uncertain in operation unless carefully tested and watched, and even with the most perfect arrangements they will sometimes give trouble at very inopportune times.

Ignition by a hot platinum tube has been frequently tried by the French, but this necessitates a burner and fire to heat the tube, and deprives the gasoline motor of the element of safety it otherwise has by the presence of the burner flame.

What has been chiefly needed to make the explosive motor well-nigh perfect is an automatic sparking plug that can be operated without electricity, is not affected by oil or soot, and is durable and inexpensive. Such a plug, the invention of a French chemist and physicist, Monsieur A. Wydts, is described elsewhere in this issue. It is based on the well-known property that platinum has of becoming incandescent in the presence of oxygen mixed with hydrogen or other gases. Monsieur Wydts has made an alloy of some metals of the platinum group that has the same property in a greater degree than platinum and yet is much harder and more durable. This is practically the essence of his invention.

If the Wydts sparking plug continues to show in practice the results obtained in its first trial, we think the gasoline motor problem will be found completely solved. There will no longer be any uncertainties about the gasoline automobile, and this power will be put to many uses where certainty of operation is an absolute essential. The invention of a perfectly reliable sparking plug will also have much to do in advancing the perfecting of other types of explosive motors, such as the alcohol, the kerosene and the acetylene.

ELECTRO-OPTICAL PHENOMENA.

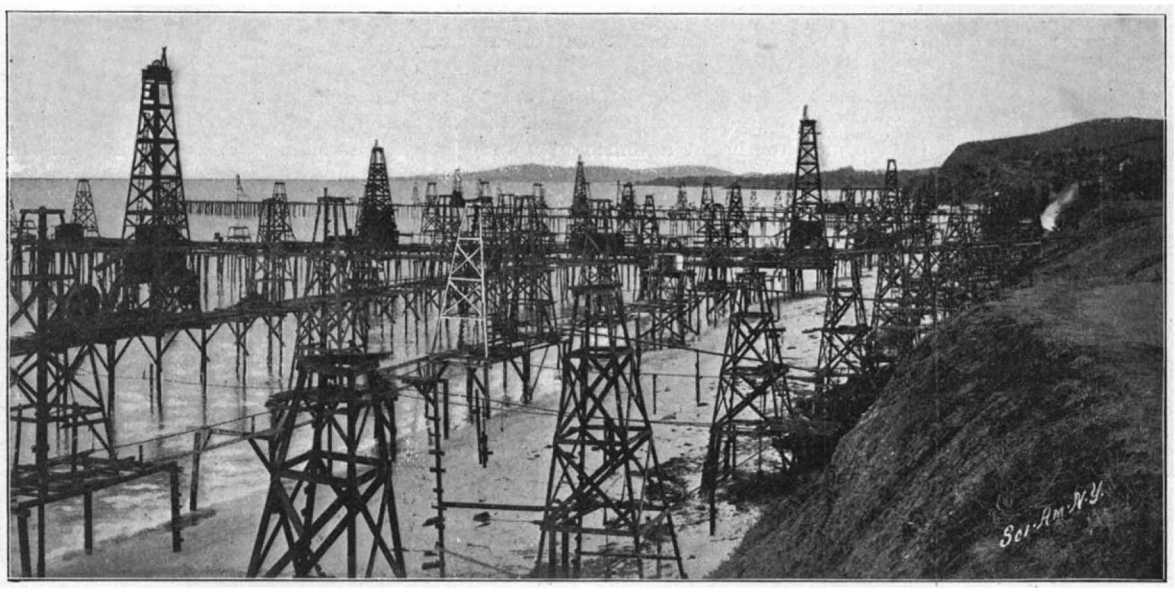
The electro-optical phenomena which have been recently discussed by Dr. Emile Bose, of Breslau, are interesting both from a theoretical and practical point of view. The experimenter finds that when a current of long duration is passed through a slightly acid solution, using gold electrodes, the anode becomes changed in appearance, and is covered with a layer of hydroxide. If the current is now stopped and the electrodes connected to a sensitive high-pressure galvanometer, the latter indicates a current whose intensity varies with the amount of light thrown on the plate covered with the layer of hydroxide. By using an arc lamp as a source of light, a difference of potential as high as 0.1 volt between the plates has been found. This depends upon the color as well as the intensity of the light. It is shown that a strong white light diminishes the potential. As to the different parts of the spectrum, violet light has the same action as white light; sodium rays and the yellow in general seem to have no appreciable effect, while the red, such as a lithum flame, increases the potential above the value which it has in the dark. The X-rays are found to have a decided action, resembling that of white light. This phenomenon is interesting from the fact that the different parts of the spectrum, red and violet, instead of differing in their action only in degree, here differ in direction and produce contrary effects. Dr. Bose is making experiments to show whether the effect is proportional to the intensity of light, and in this case the principle may prove to be of value in photometric work.

The Kansas City, Mexican and Orient Railroad has awarded a contract for steel rails to a European company, the rails to be furnished for the construction of the road in Mexico, and the contract payment is to be made with Mexican government subsidies, which are to be turned over to the company furnishing the rails, and the difference between the cost of the rails and the value of the subsidies, after all expenses have been paid, is to go to the construction company. The rails are to be of Belgian manufacture, and will be shipped in lots sufficient to lay sixty-two miles of track.

THE DRILLING OF SUBMARINE OIL WELLS AS PERFORMED AT SUMMERLAND, CAL.

BY DWIGHT KEMPTON.

At Summerland, Cal., there are about one hundred submarine oil wells in successful operation, and as many more wells scattered along the beach between the limits of the highest and lowest tides. The wells farthest from shore are in from 15 to 25 feet of water at low tide. The method of drilling these wells as compared with the gigantic projects proposed for reclamation by walling off the sea on the coasts of Bibi-Eibat and the island of Swjitoi, or the draining of Romany Lake at Baku, for the purpose of drilling petroleum wells, is simplicity itself.



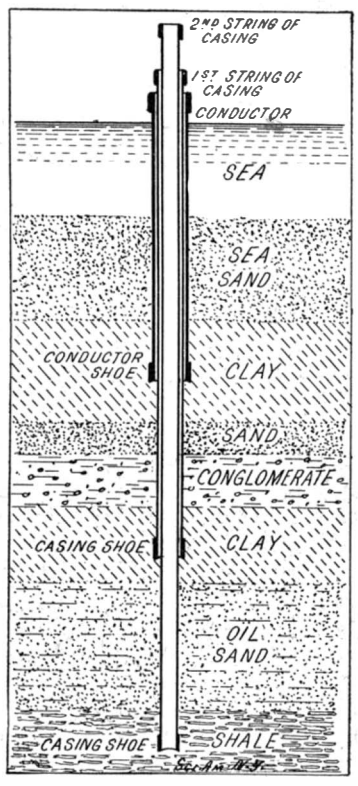
GENERAL VIEW OF THE WELLS AT THEIR THICKEST PART.

The drilling of submarine oil wells, as performed at Summerland, primarily involves the construction of a wharf from the shore to some point over the oil-producing strata, or across the region where the borings are contemplated. In strength of structure these wharves have been built in considerable variety, from those consisting of a mere double row of piles with 8 x 8 cross-beams and stringers and with a narrow walk from one to five feet wide as the only means of access to the wells situated upon them, to strong and commodious structures thoroughly planked and capable of withstanding either the heaviest southeasters which visit that coast or bear any kind of traffic to which a wharf might be subjected.

A peculiar condition in connection with these wharves, which is of uncommon interest, is their immunity from the teredo. The oil wasted from the many wells both on the wharves and on shore is often seen floating on the surface of the sea. This either drives off the destructive teredo (*Xylotria pennatifera*), which are quite plentiful in those waters, or else makes it impossible for those pests of the sea to find lodgment in the oil-coated piles. The oldest piles have been driven nearly four years, and there has been no deterioration whatever in any of the wharves due to shipworms or any other form of marine life.

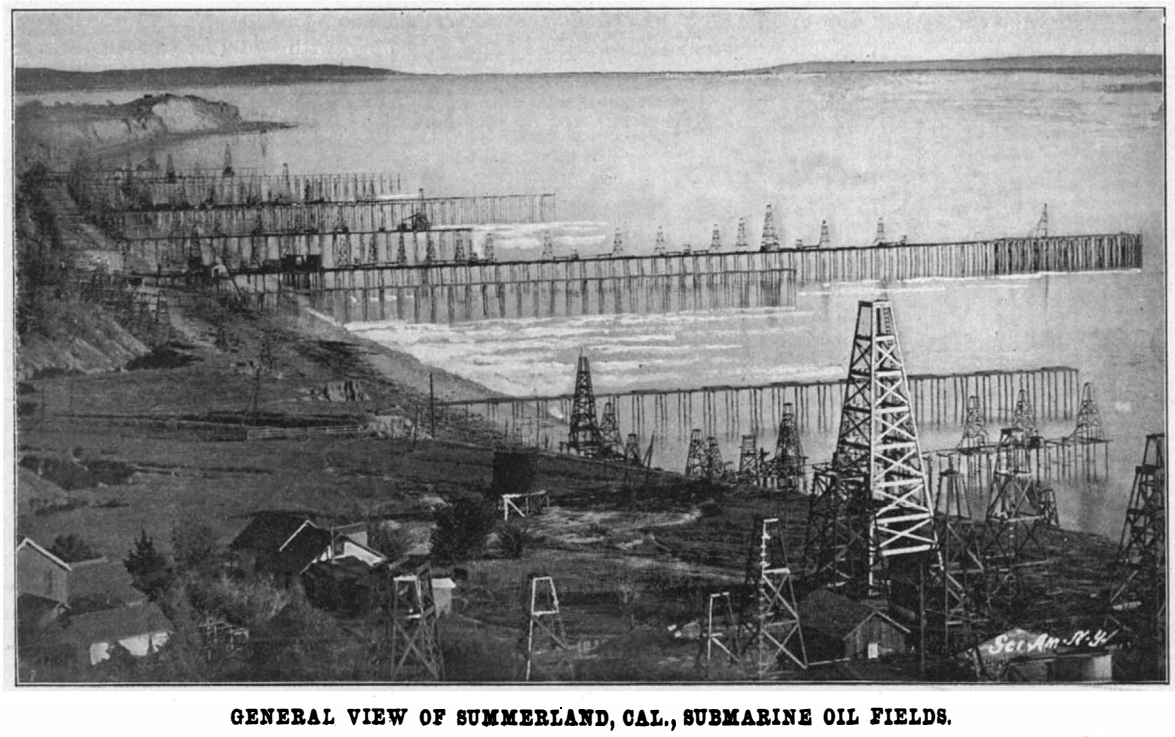
Upon the completion of the wharf, or so much of it as is necessary for the immediate purpose, the drilling machinery is assembled at the location for a well. In beginning the drilling operations the first important work to be done is in putting down what is locally termed a "conductor." The conductor consists merely of oil-well casing of a size larger than that with which the well would have been started were there no sea to contend with. Often casing of inferior quality is used for this purpose, and it is sometimes put down without a shoe where the previous borings indicate that no cobblestones will be met in passing through the sea sand. Usually 9⅝ casing is used, but for the shallower wells 7⅝ is sometimes adopted.

In starting the conductor in from 15 to 25 feet of water, two joints of 9⅝ casing are screwed together, making a length of from 30 to 45 feet, or of sufficient length so that when the shoe or bottom end is resting on the sand under the water, the top end will extend well up toward the top of the roof in the derrick. In setting it, the conductor is held suspended by the sand line in an upright position with the shoe about a foot above the sand. It is then plumbed as nearly as can be, and, watching a favorable opportunity when the wash of the water is least violent, it is suddenly dropped to the sand. It is then accurately plumbed while resting on the ground under the ocean, and is secured in its vertical position by means of boards nailed to the derrick floor in such a way that their edges bear against the casing from four different directions. The drilling stem, which has been previously fitted with a driving head and clamps, is then run into the conductor, and it is driven into the sand as far as it will safely go. Then the clamps are removed and the drill set to work, and by alternate drivings and drillings the conductor is worked through the sand to the clay beneath, where it is discontinued. By the time the top of the conductor has been driven to the level of the derrick floor the bottom end has become so deeply embedded in the sand that the stays can be removed and the casing driven beneath the derrick to a point near the level of the water underneath. Should it then prove too short to penetrate the sand,



SECTIONAL DIAGRAM SHOWING THE RELATION OF THE CONDUCTOR TO THE REST OF THE CASING IN A SUBMARINE OIL WELL.

other lengths are screwed on and the operations continued until that object is attained. When the conductor has been driven a few feet into the clay underlying the sea sand, the ocean is as effectually shut off from the well, for all practical purposes, as if it was held back by a dike or sea wall. However, there is still danger of letting the ocean water into the well through the carelessness or incompetence of the driller. It is quite essential to change the drilling bit to the next smaller size immediately on stopping the conductor or whenever it is decided to go no farther with any size of casing, and also to keep the casing following closely after the drill. Otherwise, when drilling ahead of a conductor or casing that is permanently stopped, before reducing the size of the bit, there is danger of water breaking through from above into the new boring; and when drilling too far ahead of the casing the tools are liable to gain more and more swing, cutting the hole larger and larger, especially in either clay or shale strata, thus creating a cavity of much greater diameter than the casing will fill and which frequently becomes a watercourse outside of the casing for the ruin not only of the well, but also of the adjacent oil territory. In other respects the drilling of submarine wells differs little from those put down on land.



GENERAL VIEW OF SUMMERLAND, CAL., SUBMARINE OIL FIELDS.

Ball Lightning at Sea.

Robert Seyboth, of the United States Weather Bureau, tells of an experience with ball lightning while at sea in Hudson Bay in 1867. The phenomenon was witnessed during a storm.

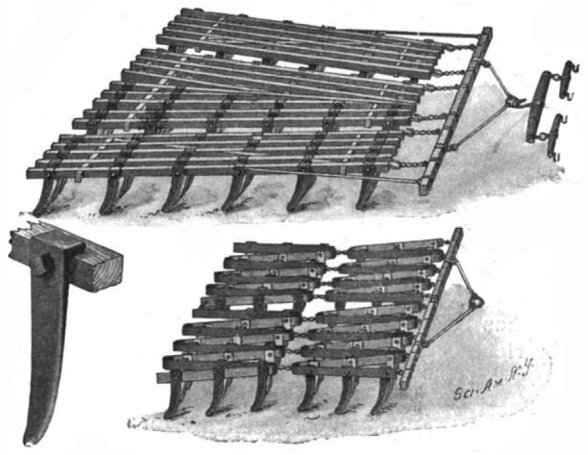
"Happening to secure the upper hold on the foretopsail brace, the writer facing sternward, again noticed the evil-looking thunderhead, apparently but a few yards above the mizzen truck, and, while waiting in silent expectancy for the thing to come, saw a ball of fire the size of a man's head detach itself from the cloud and sail quite leisurely to the mizzen truck, striking which it exploded with a deafening crash and sent a shower of hissing sparks over rigging and deck.

"Of the immediate consequences, save one, the writer can only speak from hearsay. When he regained consciousness he found himself sitting, propped up against the weather side of the mainmast, paralyzed in the right half of his body, and his shipmates busily engaged, some in clearing away the wreckage of the shattered mainmast, others in sounding the pump to discover whether or not the bolt had knocked a hole in the vessel's bottom. The latter calamity was probably averted by the fact that the lightning had found an easier escape to the water by way of the anchor chains, through the hawsepipes, as both anchors had been made ready to let drop in case of the vessel's inability to weather the rocks. The one exception above noted, and which he has accepted as a proof that the velocity of thought is greater than that of lightning, was his distinct realization, at the critical moment, that he had been struck by lightning and was being hurled to the deck, though consciousness failed him before he struck it. He also had time to formulate the thought, 'Well, it is all over with you this time,' and feel rather gratified at the supposed fact. There was absolutely no pain felt, not even an unpleasant sensation; on the contrary, he seemed to sink into an agreeably restful position, though, according to his shipmates' statements, he was hurled with great violence into the lee scuppers. Of the other men on deck, especially those having hold of the brace, every one was more or less shocked, but none were rendered insensible. The writer's uppermost hold on the rope had evidently deflected the greater part of the charge through his body. The paralysis of his right side was gradually succeeded by a prickling sensation, and the movement of his limbs had again become possible by the time the watch was told to go below."

A NOVEL HARROW-TOOTH.

A harrow-tooth that will cut and therefore will not clog is an invention for which Mr. Augustus H. Schaffer, of Ontonagon, Mich., has received a patent.

The tooth is made of flat spring-steel, is tapered, and is formed with a rectangularly-extending flange at its upper edge, which flange is intended to fit snugly over a harrow-tooth bar. The one side face of the tooth is convexed and the opposing side concaved. Furthermore the front, cutting edge of the tooth is sharpened and convexed, and the back concaved. Teeth of this form



THE SCHAFFER HARROW.

cut through the ground and do not clog, but form sharp furrows. After a harrow fitted with the teeth has been passed over a field, the surface of the ground is thoroughly sliced, but still smooth and level.

Mr. Schaffer intends to apply his invention to harrow-frames of peculiar construction. One of his harrow-frames is made of 2 x 2½-inch hardwood, with longer dimension upright. Six teeth are fitted to each full-length piece. A beam, the length of which is as great as the average width of the harrow, is attached to the front of the harrow by means of hooks and links. At each end of this beam a rod extends backward along the side of the harrow, and is attached at a point near the center of the outside piece.

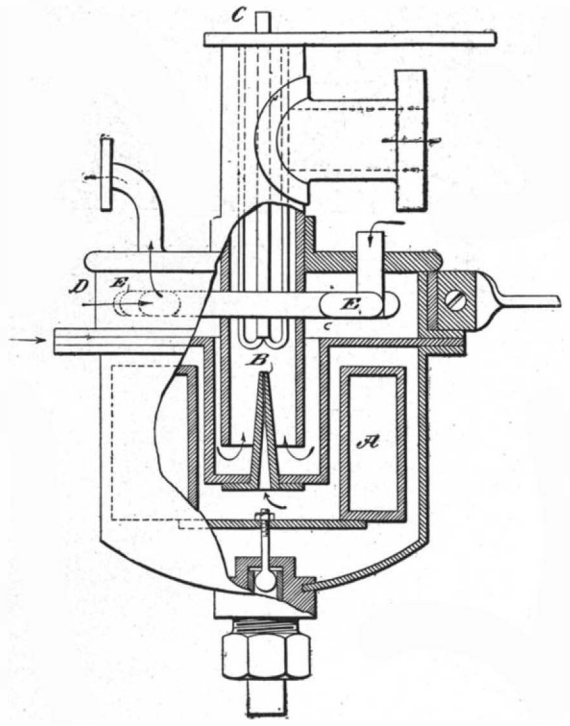
Another form of frame is made of steel sections, bent zigzag and connected by links. The beam running across the front of the frame is hinged at the middle.

ALCOHOL AUTOMOBILES AT THE PARIS ALCOHOL EXHIBITION.

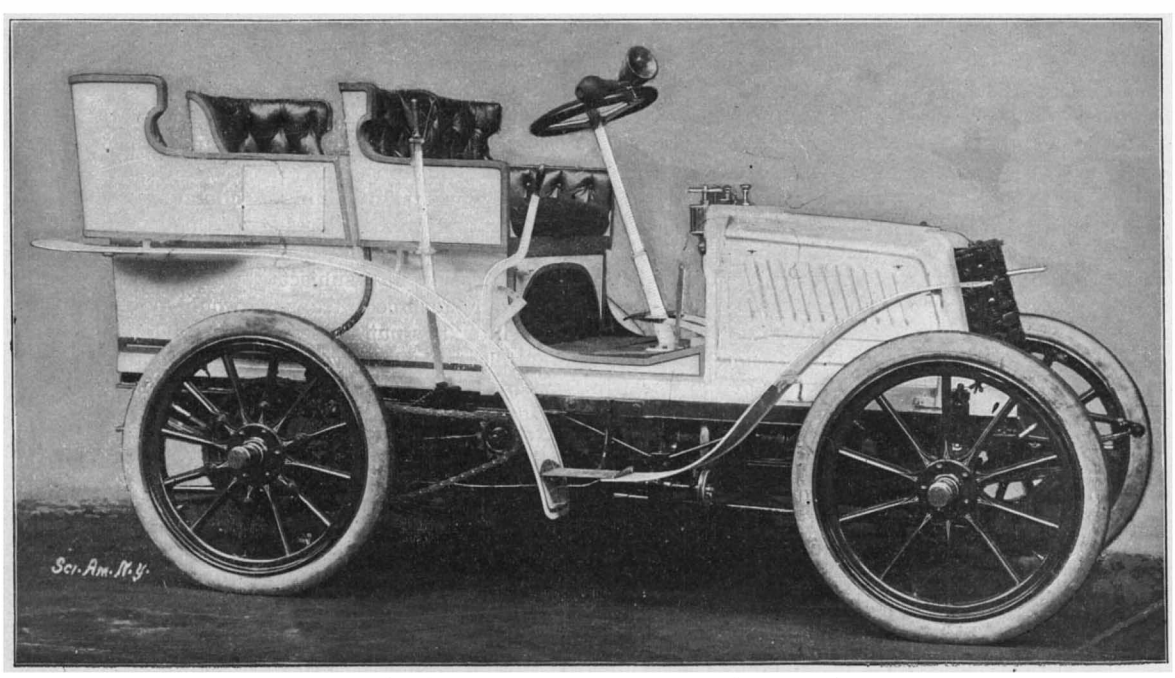
BY OUR PARIS CORRESPONDENT.

II. THE BARDON.

The Bardon automobile, shown in the illustration, is one of the recent type. In this machine the motor, which is horizontal, is placed transversely and in the front of the truck. It has one or two cylinders each provided with two pistons, the explosion taking place between the two. The pistons drive a crank-shaft at either end, and these are connected with the main driving shaft by bevel gearing; the latter shaft, in turn, drives the rear wheels by chain gearing. The motor is thrown in gear by a conical friction clutch operated by a pedal, and the speed-changing device has a set of gears of different diameters which are alternately placed in mesh. Electric ignition is used. The carbureter, of the Leblond type, works on the atomizer principle. It is designed to heat the gaseous mixture before it passes to the cylinder. As shown in the diagram, the chamber contains the hollow float, *A*, which carries below a ball-valve to regulate the admission of alcohol; this arrangement allows for the inclination of the apparatus. Above is the atomizing tube, *B*, from which the liquid is projected upon a set of small heating tubes of copper, traversed by a part of the exhaust gases. These are brought by a large central tube, *C*, and mount through the six small tubes. The alcohol gas is also heated by a copper spiral, *E*, through which part of the exhaust passes. The hot air for forming the gas passes downward and then up past the atomizer nozzle, drawing up the alcohol in the usual manner. The mixture is made at the desired temperature by regulating the temperature of the inrushing air. The entrance of air for the mixture is regulated by a revolving collar with air holes in the top of the carbureter. The gas goes to the motor through the large pipe above the carbureter. The Bardon type is among the most successful of the alcohol automobiles, as it obtained the first prize (gold medal) in October, 1900, in the Paris-Rouen and two other medals in the Paris-Roubaix races of this year. This system is one of the few to use pure alcohol.



THE BARDON PURE ALCOHOL CARBURETER.



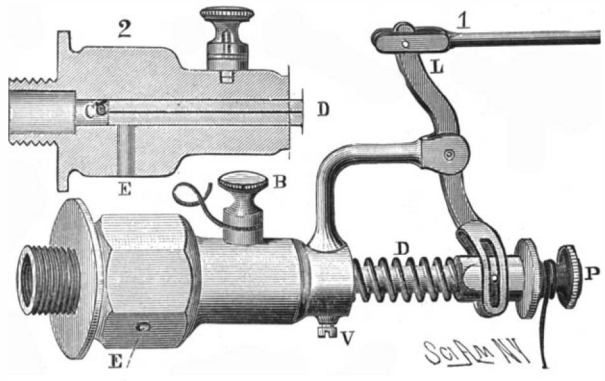
THE BARDON ALCOHOL AUTOMOBILE.

THE WYDTS ELECTRO-CATALYTIC SPARKING PLUG.

A new sparking plug for gasoline engines has recently been invented by Mons. A. Wydts, a French electrician and physicist of note. This plug accomplishes the rather startling feat of exploding the charges of gas in a gas or gasoline engine without the use of electricity (except a very small current when starting) or heat. It is not affected in the least by a sooty mixture or by oil, and is in fact the plug *par excellence*, according to M. L. Baudry de Saunier, the editor of La Locomotion, who has given it a thorough trial, and from whose description of it we give the following facts:

It is well known that certain precious metals have the extremely singular property of bringing about merely by their presence the sudden combustion of two or more gases in which they are placed. This phenomenon occurs the more easily when the metal is finely divided, for while it has the same volume, there is a greater surface exposed to the gas. If, for example, a piece of osmium is placed in a mixture of hydrogen and oxygen, it has to be heated to about 200 deg. C. (392 deg. F.)—a temperature far too low to bring it to a red heat, however—in order to produce an explosion. If this compact piece is replaced by a piece having the same volume, but in a finely divided state—by some osmium sponge, in other words—it is only necessary to heat it to 40 deg. or 50 deg. C. (102 deg. to 122 deg. F.) for the phenomenon to occur. Finally, if for the spongy piece a piece of the powdered metal having the same volume be substituted, the explosion will occur without any heating being necessary.

The metals which produce, to use the expression of the physicists, this catalytic effect, are platinum and those that are mined with it, such as osmium, iridium, rhodium, and ruthenium, which are found in the nuggets or grains contained in the auriferous earths from which platinum is extracted. Theoretically, therefore, it is only necessary, in order to automatically spark a motor, to mount on the piston a piece of spongy platinum. Several attempts have been made to do this, but they have all proved abortive; and thus it is demonstrated once again that, if theory and practice are sisters, they spend the greater part of their lives quarreling. The fact is that platinum, even in the spongy state, has not sufficient catalytic power, when cold, to explode a mixture, and motors that are provided with this metal for ignition purposes must have it heated by a burner when starting. Afterward, when the internal temperature of the cylinder has become sufficient, the burner is extinguished and the



THE ELECTRO-CATALYTIC SPARKING PLUG.
1. The plug with operating lever. 2. Cross-section of plug.

spongy platinum alone effects the explosions. Spongy platinum produces the same result as a heated point in a motor run without cooling water; it causes explosions at the wrong time and haphazard. Moreover, spongy platinum can only be obtained by causing meerschaum (an extremely fragile substance) to absorb a platinic chloride, which is then reduced to the metallic state. It has no resistance and will only last throughout a laboratory experiment, the length of a morning.

In order to evolve from these curious experiments a really practical spark plug, capable of traversing the highways on an explosive motor, numerous minor discoveries remained to be made. An experimenter of ability was needed to undertake them, and such a one was found in Mons. Wydts, who not only had the ability, but also the inventive genius to bring them to a successful and practical termination.

It was necessary, in order to make a successful igniter on this principle, to find a solid, homogeneous, indestructible, unoxidizable substance capable of a sufficient catalytic effect, even at low temperatures, to inflame any carbides of hydrogen whatever mixed with a small proportion of oxygen and a large proportion of nitrogen and other gases.

After long research, Mons. Wydts discovered an alloy, made in determined porportions, of osmiridium and ruthenium, an alloy which forms a metal of an extreme porosity although always dense, and which possesses in the highest degree the power of condensing with elevation of temperature any carbides of hydrogen whatsoever mixed in any quantity whatsoever with nitrogen, oxygen, carbonic acid, etc. The presence of an infinitesimal quantity of hydrogen causes its immediate incandescence.

At the same time the inventor discovered that the passage of an electric current through this mysterious alloy produced a sort of molecular bombardment, the effect of which was to drive out the inert gas condensed in the pores of the metal, to purge it in some manner, and by so doing to increase its catalytic power. A feeble current (one-half an ampere at one volt, or one-half a watt) is sufficient, and its application is necessary for a few seconds only. After making some experimental plugs, Mons. Wydts has now devised a standard type suitable for any gasoline engine. This consists of an outer shell or casing that screws into the regular spark-plug hole in the motor. Within this shell there is a metal piston, *D*, which can be moved in or out by means of the lever, *L*. An insulated wire passes through the piston, terminating in the bit of metal alloy, *C*, on the inner end and having a binding post on the outer end. The bit of alloy is mounted on the end of the piston, and as this fits tightly in the outer shell, the current can enter through the upper binding post of the latter, pass through the shell and piston to the alloy, and, after

traversing this, make its exit through the insulated wire and the binding post, *P*. A single cell of dry battery is all that is needed, as it is only necessary to produce a sort of excitation in the bit of alloy at the start, and as soon as the motor is under way the current can be cut off. The electrical apparatus used is certainly of extreme simplicity.

As soon as the motor is well started, the point of ignition becomes somewhat advanced, for the incandescence of the bit of alloy increases gradually till its maximum is reached. It then has a temperature of 1700 deg. C. (3092 deg. F.), a temperature superior by 750 deg. C. (1382 deg. F.) to that obtained by the best burners.

It is noteworthy that this temperature is lower than that of the electric spark, which is generally conceded to be in the neighborhood of 3000 deg. C. (5432 deg. F.). But, in a unit of time, the number of calories disengaged by the osmium (and this is the important point in the discussion) is much greater than the number disengaged by a spark. A piece of wool saturated with gasoline, and approached in a closed jar toward the osmium and toward the spark, takes fire three centimeters away from the former and only ignites when within one-half a centimeter of the latter.

The inflaming alloy, therefore, forms in the Wydts plug an incandescent center comparable to that which the burner forms in a platinum tube. But the great difference consists in this, that in the system just described, this incandescent center, *C*, can be moved while, when produced by a burner, it is fixed. The result is that while in order to produce advance ignition in a motor with burners, it is necessary to use a platinum tube longer than the one ordinarily employed, and thus render necessary in this tube a lower compression, that is to say, a compression more quickly obtained by the piston, inversely it is necessary with the Wydts igniter to shorten the length of the chamber by advancing the incandescent point toward the cylinder.

The useful ignition advance for a given motor can be calculated by the constructor, who can set the piston in the plug and fasten it by the screw, *V*; or it may be obtained by hand by moving the piston when the motor is in operation. The sudden stopping of ignition can be accomplished by withdrawing the incandescent mass past the hole, *E*. The introduction of the oxygen of the atmosphere affects the incandescent piece of alloy, in that it suddenly lowers the temperature to a point sufficiently to interrupt ignition, while at the same time it spoils the explosive mixture in the cylinder. The motor consequently stops at once. To start it again, all that is necessary is to push in the piston sufficiently to close the hole, *E*, connect the battery in circuit, and give a turn of the crank. Twenty seconds after, the current is cut out, and the motor runs as before. If the motor had been stopped in some other manner, and the igniter piston left as far in as possible, the operator need have no fear of its kicking back when he attempts to start it, for the incandescence of the osmium would then be at its minimum, and the explosion would occur at a point sufficiently behind that where it occurs when the alloy has reached its maximum incandescence to make a back kick impossible.

Finally, after having taken the Wydts plug out of the motor and smeared it with oil and soot by means of a brush, I saw the motor start at the first turn after the plug had been re-inserted. Five minutes later, upon taking out the plug again, I found the osmium alloy bright and showing no trace of the foreign substances.

Prevention of Malaria.

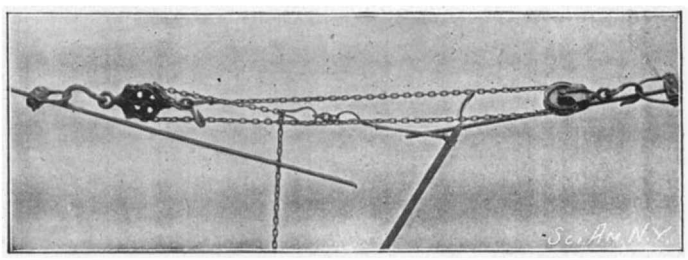
Major Ronald Ross has practically succeeded in ridding Freetown, the capital of Sierra Leone, from malarial epidemics. Malaria, yellow fever, and elephantiasis have all been sufficiently shown to be carried by tropical gnats. These are the principal and possibly the sole means of infection; and although that has yet to be demonstrated, his "object lesson" will probably settle the doubt. The gnats in question are Anopheles, Stegomyia, and Culex, the first of which breeds in puddles, the second and third in rubbish heaps. Dr. Logan Taylor, the head of his Freetown staff, was therefore instructed to hire a body of scavengers who would drain or fill up pools and puddles in the streets, and to clear the back yards of broken bottles and buckets, empty tins, old calabashes, and so forth. The Culex gang, under a native headman, removed the rubbish into carts and subsequently discharged it into an assigned rubbish shoot. At the same time, they showed the larvae to occupants of houses, and instructed them in the manner of destroying them by emptying the vessels, or by dropping a little oil on the surface of water in which they live. By this means about fifty houses were cleaned. In less than three months the gang had visited 6,500 houses in a town of 40,000 inhabitants, and disposed of more than 1,000 cart loads of rubbish. The effect can be imagined when it is remembered that about one-third of the tins and bottles contained larvae during the rainy season, at which time they were destroyed. Every house had been breeding mosquitoes in its own backyard, or garden. The Anopheles gang had a more difficult task. The streets, yards, and gardens possessed numerous pools of rain water. Some were filled with earth, rubble and turf. Others were evacuated by cutting through the rock which contained them, or by making channels in the soft earth. Several men were specially employed in brushing out with brooms, or treating with crude petroleum or creosote, those puddles which the rest had not had time to touch.

A LEVER-DEVICE FOR OIL-RODS.

In oil fields, a central power is often connected by pump-rods with the several pumps located at a distance. Sometimes a pump-rod breaks and the several portions move apart. An extremely useful device for enabling a single operator to draw the parted ends together has been invented by Mr. Asahel C. Smyth, of Bolivar, N. Y.

Mr. Smyth reeves a hauling-chain through two pulleys attached respectively to the severed parts of the pump-rods. A pivoted grappling-hook and a grabring connect the free end of the chain with a link pivoted on a lever having a grappling-hook embracing the main run of the chain. By locking the lever grappling-hook and chain together and swinging the lever in one direction, it follows that the attached pump-rod is drawn along. When the lever has reached the end of its stroke, its grappling-hook is disengaged from the chain, and the chain will be locked by its grappling-hook. By swinging the lever now in the opposite direction a new fulcrum is obtained for a repetition of the operation. In this manner the free end of the chain is gradually moved along with the chain passing around the pulleys, thus drawing the sheave and rod along half the distance the free end of the chain has been moved.

By means of a short branch-chain for engagement with the link, a pair of connected hooks for securing the runs of the chain in front of the one sheave, and an S-hook for taking up the slack of the chain, it is possible to continue the successive pulls on the rod, when the lever device reaches the fastened end of the chain and the two parts to be drawn together are still separated.



SMYTH'S LEVER DEVICE.

THE YEAR OF 1901 IN THE KLONDIKE.

BY JAMES HAROLD THOMPSON.

It is the history of a "Placer Mining Camp" that its life is short and eventful, while it lasts, and that it springs rocket-like into prominence and sinks gradually after having reached its years of plenty into a thing of the past.

The Klondike has reached the crucial year of its existence. "For hope's sake" many have continued their confidence in the future of Dawson; the hub of what has been the richest placer mining camp of this and possibly any other decade. The hope of those interested in commercial enterprises along the Canadian Yukon is the discovery of quartz in paying quantities.

As to the future of the mining district which in 1897 so startled the world and which since then has been such an abundant gold producer, known as the Klondike mining district of the Northwest Territory of Canada, its future depends upon the discovery of well placed quartz. It is acknowledged by the conservative knowing ones that the days of big profits in mining and commercial enterprises are past and are only present now in reminiscence. Overland and water navigation from the coast, with its difficulties, are now subject to modern systems of railroad and steamboat transportation, and when the Arctic winter has put its seal upon this northern country, the telegraph daily voices the events of the world in Dawson.

Heretofore merchants and tradesmen reaped big harvests, 100 per cent being not an uncommon profit. Yet it was seldom that capital profited its owner more than once a year because of navigation and railroad facilities. The short season beginning in June and ending in October, coupled with the lack of telegraphic communication, allowed time for but one shipment during the year. As a consequence the necessities of life were ofttimes cornered and prices in some instances reached prodigious heights. As competition became a factor many of the larger commercial enterprises drew together and amalgamated their interests. Two companies now control the market. In every department of mercantilism competition is keen, excepting in one which is a very essential one here. That one is the oil trade. The Standard Oil Company has complete control, and it retails a case of kerosene at $12.50 per case. The same case of oil sells for from $2 to $3 in the States. Merchandise is delivered in Dawson for from $70 to $90 per ton, just about half of what it was in 1899. And yet this price is deemed abnormal by the importers and a strenuous effort is being made to have it reduced to $50 per ton. The cost of mining has been cheapened by the use of steam and machinery, enlarging the yearly output of gold much over what it would have been under the crude methods of the "sour dough."

Government regulations have somewhat hampered the prospector, but withal he has been quite vigilant and has as yet discovered nothing since 1898 to perpetuate the reputation the Klondike has had as a gold producer. Claims upon the banner creeks whose reputations as gold mines have equaled the wildest hopes of the pioneer prospector are gradually being deserted and to-day half, I might say two-thirds, of Eldorado Creek has been worked out. The same is true of the other rich spots of a few years past. The life of the camp, from what is in sight, can be estimated at this date.

Prospecting for quartz is occupying the attention of many hard-rock miners along the Yukon and its tributaries. Upon the successful solution of the quartz question depends the present prominence of Dawson as a mining camp, and it is the one thing talked of and hoped for by the present inhabitants of this district. As yet nothing of any permanent value has been discovered, although many of the numberless claims staked and recorded are being worked quite thoroughly. Companies have been formed and their stock is on the market. Their hope is that the present prospects will lead to the substantial vein, or the "Mother Lode," as it is called. To facilitate the sorting, handling and assaying of these prospects two fine stamp mills have been erected in Dawson and are now crushing quartz rock.

Prior to the discovery of the Klondike district it was found practical to thaw the frozen earth to almost any depth by the use of wood fires. Hence as the gold lies in or above the bed rock ground, when the bed rock was one hundred feet below the surface it could be worked as well as that of twenty-five feet. The winter season being the longest and driest season it became the busy season for the miner. But steam and machinery have reversed this order of things, and as in the days of the oldest "sour dough" miner, summer, although the season is but six months long, has become the time of activity. The majority of heavy operators discontinue altogether the operation of their properties and spend the winter months at their ancestral homes, wherever they may be. As a consequence, the work accomplished this winter will not compare at all favorably with that done during the preceding winters. It also means a busy summer season for 1902. Considering those changes, the consensus of opinion of those conversant with this district is that the output of gold will decrease from this year.

Gold mining will continue here for some time. This is the history of similar camps. Capital will gradually withdraw, and individuals who will be content with wages for their labor will work the old workings. These are known as "snipers" in the vernacular of the miner.

The development of the unknown resources of the vast land known as Alaska and the Northwest Territory should be of constant interest to the farmer, merchant and manufacturer of the United States and Canada. Directly and indirectly it is of vital importance to these mother countries. The actual necessities of the man living next door, too, and within the Arctic circle will support a larger portion of labor than the similar necessities of any individual living in any other portion of the globe. Good pure food; plenty of it; abundance of well-made clothing are absolute necessities for the health and preservation of life in this cold climate. If peopled as it should be, were the resources of this vast territory but opened up in a limited degree, the commercial world of the North American continent would have a market open to their products which would be the surest in times of depression, the most profitable and congenial for the absorption of the congested material.

Experiments have proved that the hardier cereals and vegetables can be successfully raised within the Arctic circle, but the season is so short that competition in this line will not become a factor for many years. The advent in the manufacuring line, factories, etc., is not to be considered. Beef has thus far come from the Western States and British Columbia, and the winters are found too severe for stock raising.

Legislation can greatly facilitate the work of those who are destined to develop and pioneer the many industries which will some day flourish here.

American granite is being shipped to Liverpool.

A COMPARISON OF THE PANAMA AND NICARAGUA CANAL ROUTES.

In response to a large number of requests for a more complete treatment of the Isthmian Canal question than we have yet presented in the SCIENTIFIC AMERICAN we devote the current issue of the SUPPLEMENT entirely to this subject; moreover, on the front page of this issue of the SCIENTIFIC AMERICAN we present by map and diagram a condensed comparison showing the advantages of one route over the other. The SUPPLEMENT opens with two complete articles on the Panama and Nicaragua routes, which are based upon the reports of the International Commission on Panama and of the Nicaragua Canal Commission on the more northern route. In the same issue will be found an elaborate digest of the report, just issued, of the Isthmian Canal Commission. Our front page maps and diagram are based entirely upon the last-named report, which, by the way, is far the most complete and exhaustive document of the kind ever published, and will in all probability be accepted as a final statement of the case.

GENERAL DESCRIPTION.

The two canals have certain features in common. In both the greatest problem is the maintenance of the summit level and the control of the flood waters of rivers which are subject to extremely heavy freshets. In both cases the plan determined upon seeks to make the one difficulty cancel the other, the flood waters of the rainy season being stored by the erection of large dams across the course of the rivers, the dams being associated with spillways, or waste-weirs, by which the impounded waters may be regulated between predetermined maximum and minimum levels.

PANAMA.—The route of the Panama Canal extends from the six-fathom line in Colon Harbor on the Atlantic to the six-fathom line off Panama on the Pacific, a distance of 49 miles. The physical difficulties consist of the Culebra cut through the continental divide near the Pacific, and the floods of the Chagres River, which latter flows down from the northeast, intercepts the line of the canal at about its center, and coincides more or less with the general route of the canal from the point of interception to its Atlantic terminus. The problem is to be solved by cutting a tide-level canal for the first 16 miles from the Atlantic to Bohio, where a dam will be thrown across the Chagres River, the dam to be of sufficient height to form a great lake in the valley of the Chagres, whose maximum elevation will be 90 feet above mean sea level. Allowing for the greatest possible variation due to continued drought or to heavy freshets, the level of the lake will be maintained between the extremes of 82 feet as a minimum and 90 feet as a maximum level above the sea at mean tide. The surplus waters of the rainy season will be discharged over a weir 2,000 feet in length, which will be built not far from the Bohio dam, the waste waters being conducted to the Atlantic partly by the Chagres River and partly by artificial channel. At Bohio will be located a double-lift lock with a total maximum lift of 90 feet. The line of the canal traverses the Bohio lake thus formed for a distance of about 14 miles, or until it reaches Obispo, where there will be placed a set of gates 100 feet wide, the purpose of the gates being merely to retain the waters of Lake Bohio should it at any time be desirable to drain off the waters of that portion of the summit level lying beyond the gates. Passing through the gates the canal enters the Culebra section, which consists of a great cut through the continental divide. This section is about 8 miles in length, and at the Pacific end of it are the Pedro-Miguel locks. Then follows a level 1.33 miles in length, which leads to the Miraflores locks, by which descent is made to tide level on the Pacific. From the Miraflores locks to the 6-fathom line on the Pacific is a distance of 8.5 miles.

NICARAGUA.—Although the route of the Nicaragua Canal is nearly four times as long as that at Panama, the cost of its construction, while greater by about $6,000,000, is nothing like proportionate to its greater length. Topographically considered, the controlling features at Nicaragua are the existence of a great deep-water lake near the Pacific, and its connection with the Atlantic Ocean by the Rio Grande, a river of considerable size and discharging in the rainy season an enormous volume of water. Starting from Greytown on the Atlantic, the canal will be excavated generally along the edge of the delta formed by the San Juan River until it enters the river channel at a distance of 46 miles from the sea. Three miles further down the river, at Conchuda, it is proposed to build a great dam across the San Juan River, whose crest will be of sufficient height to raise the surface level of the impounded waters to a maximum elevation of 110 feet above mean sea level. The difference of level will be overcome by four locks at various points on this section. This dam will have the effect of canalizing the San Juan River from this point to its point of outflow from Lake Nicaragua, a distance of 49.64 miles. Where the sharper bends of the river occur, cutoffs will be made. The distance across Lake Nicaragua, 70.51 miles, will lie chiefly in deep water; but the approach to the canal at each side of the lake will have to be dredged to obtain the necessary depth of 35 feet. The remaining 17.34 miles of canal from the western shore of the lake to deep water on the Pacific will contain four locks, by which the difference of elevation of 110 feet will be overcome.

SUMMIT LEVEL.

PANAMA.—The average summit level proposed by the Isthmian Canal Commission for Panama is 85 feet above mean tide. This is to be secured by the construction of a dam at Bohio and a spillway nearby at Gigante, which will be a fixed weir 2,000 feet in length. Assuming a depth of 5 feet of water above the weir, this would provide for a discharge of 78,260 cubic feet per second, as against a maximum recorded flood of the Chagres River of 75,000 cubic feet per second. As a provision against seasons of extreme drought the canal will be excavated to such a depth that the summit level might fall to 82 feet and still leave the requisite depth of 35 feet throughout this section of the canal. The records of the Canal Company and of the Isthmian Canal Commission render it improbable that these extremes will be reached, or if reached, that it will be only at very rare intervals.

NICARAGUA.—The regulation of the summit level at Nicaragua is a much more serious problem, for the reason that it involves maintaining the level of the extensive Nicaragua Lake, which has an area of between 2,700 and 3,000 square miles, within certain predetermined maximum and minimum levels. It involves, says the report of the Commission, the control of the lake level within such limits "as will never permit the navigable depth of the summit level to be anywhere less than 35 feet on the one hand, nor permit the lake to rise materially beyond a determinate elevation on the other. This regulation can be accomplished by the construction of dams across the Rio Grande west of the lake and across the San Juan on the east side, both being designed with suitable wasteways for the discharge of surplus water." The minimum elevation has been fixed at 104 and the maximum at 110. The problem is a stupendous one, and limitations of space prevent any detailed discussion of it here.

DAMS.

PANAMA.—The Bohio dam is the most important structure on the line of the Panama Canal. The dam proposed by the Panama Company was to have been of clay founded upon a variety of material—hard clay, soft clay, sand, gravel, etc. The Isthmian Canal Commission very wisely decided that for a work of this importance security was a prime object to be aimed at. They decided that a masonry dam founded throughout on rock, or an earth dam with a masonry core going down everywhere to rock, would close the valley effectually and prevent all possibility of seepage. The core-wall-and-earth dam was preferred. The structure, which is to be 2,540 feet in length along its crest, will contain a core wall which will be carried down everywhere to rock, the latter being reached in places at a depth of 128 feet below the sea level. Below elevation — 30 the pneumatic process will be used in construction and above — 30 cofferdams will be used. The cost of this dam will be $6,369,640, and as it will probably take ten years to build, it will be the controlling feature in the question of time of construction of the canal. Once built, however, it will be a perfectly secure structure for all time.

NICARAGUA.—The dam designed by the Commission at Conchuda on the San Juan will be a smaller structure, and the greatest depth to rock will be only 80 feet. The regulation of the surface level will be accomplished by wasteways, vertically-moving gates of the Stoney type being adopted, each giving an opening of 30 feet on the crest of the dam. This discharge will amount to 100,000 cubic feet per second with the water in the pool immediately above it at 104. The total length of the dam, which will be entirely of masonry, will be 1,271 feet and its cost $4,000,000.

LOCKS.

PANAMA.—At Panama there will be but three locks in all, one set at Bohio, with a double lift of a maximum of 45 feet each and a total lift of 90 feet, and two sets at the Pacific end of the summit level—double-lift locks at the Pedro-Miguel and single-lift locks at Miraflores. All of these locks will be on a rock foundation.

NICARAGUA.—The ascent or descent from maximum summit level at Nicaragua will be accomplished by eight locks, four on the Pacific side and four on the Atlantic side.

LENGTH AND CURVATURE.

PANAMA.—The total length of Panama from ocean to ocean is 49 miles, and of this total 22.85 miles is curvature, the total degrees of curvature being 771. The curves are of very large radius and will present no difficulties in the way of navigation, a fact which is commented upon favorably by the Commission.

NICARAGUA.—The total length of Nicaragua from ocean to ocean is 186.5 miles, and of this 49.29 miles is in curvature, the total amount of curvature being 2,339 degrees. The greater part of this curvature occurs in the valley of the San Juan River, and owing to the limits imposed by the configuration of the valley, most of the curves are extremely sharp and must necessarily somewhat hamper navigation, particularly in the case of modern vessels of 600 or 700 feet length. An attempt is made to offset this by providing greater width in the canal on curves. There is no point, unless it be that of shortness in time of transit, in which Panama shows its great engineering and operating advantages over Nicaragua so much as in this matter of alignment.

HARBORS.

PANAMA.—The Panama Canal is greatly favored in the matter of harbors, which, by the way, are a most essential feature in the successful operation of a maritime canal. Good harbors exist both at Colon and Panama, and with the improvements suggested by the Commission they will be able to accommodate the largest shipping that seeks the canal.

NICARAGUA.—In the matter of terminal harbors, it must be confessed that the Nicaragua scheme is altogether wanting, since they simply do not exist. We publish in the current issue of the SUPPLEMENT two maps of Greytown Harbor, the Atlantic terminus of the canal, one map made in 1832, the other in 1895. In 1832 there was a spacious harbor with depths of from 18 to 30 feet of water. To-day three-fourths of this harbor is a sandy swamp, and the rest of it is a shallow lagoon with from 6 to 16 feet depth of water. An artificial harbor will have to be constructed both here and at Brito on the Pacific, and the cost of dredging to keep these harbors open will be a permanent charge upon the canal.

TIME OF TRANSIT.

It has been estimated by the Commission that a 400-foot ship would take 11 hours 14 minutes to pass through the Panama Canal, this estimate being based on a speed that varies from 7 miles an hour on curves to 10 miles an hour in Lake Bohio. It is estimated that the same vessel will take 33 hours to pass through the Nicaragua Canal. In the diagram on our front page, we have supposed that two identical passenger steamers of 18 knots sea speed enter the Atlantic termini at Panama and Nicaragua at 12 o'clock noon, January 1. By the time, 33 hours later, that the steamer at Nicaragua was at the Pacific, the steamer at Panama would be 378 knots distant on the Pacific. This gain, however, would be offset by the saving in distance and time between some of the ports on the Atlantic and on the Pacific.

WORK DONE.

The Commission estimates the value of the work done at Panama, the Panama Railroad, the maps, drawings, etc., at $40,000,000, while it states that "practically none of the property" representing work done, etc., at Nicaragua "would have any value to-day in the construction of the canal."

COST.

The total cost of completing Panama is estimated at $144,233,358, while the total cost of building Nicaragua will be $189,864,062. The Panama Company, however, have offered to sell their properties at the price named by our Commission, $40,000,000, thus making the cost of the completed Panama Canal $184,233,358. This renders the completed Panama Canal cheaper by $5,630,704 at first cost. The Commission, however, say it will cost $1,300,000 more every year to maintain and operate Nicaragua than it will Panama. This sum capitalized at four per cent and added to the cost of constructing Nicaragua, makes the Panama Canal, considered as a financial proposition, over $38,000,000 cheaper in the long run than the Nicaragua Canal.

The Current Supplement.

The current SUPPLEMENT, No. 1359, is devoted entirely to the subject of the Isthmian Canal controversy. It opens with an exhaustive article on each canal, both of which are elaborately illustrated with maps and profiles, and with photographic views taken along the route of the canals. These articles are followed by an elaborate digest of the recently published report of the Isthmian Canal Commission. The whole number forms a complete compendium of information upon this great topic. There are some 40 illustrations in all.

The Lancashire and Yorkshire Railway of England has introduced an electric motor engine for shunting purposes on its sidings at Manchester. This locomotive has been specially constructed for the purpose, and has a hauling capacity of 120 tons. It is anticipated that a great saving in working expenses will be effected by this employment of electric traction in preference to steam, while the scheme possesses the additional advantage of being less noisy, and creates no nuisance with the smoke.

SOME EXPERIMENTS WITH WIRELESS TELEGRAPHY.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

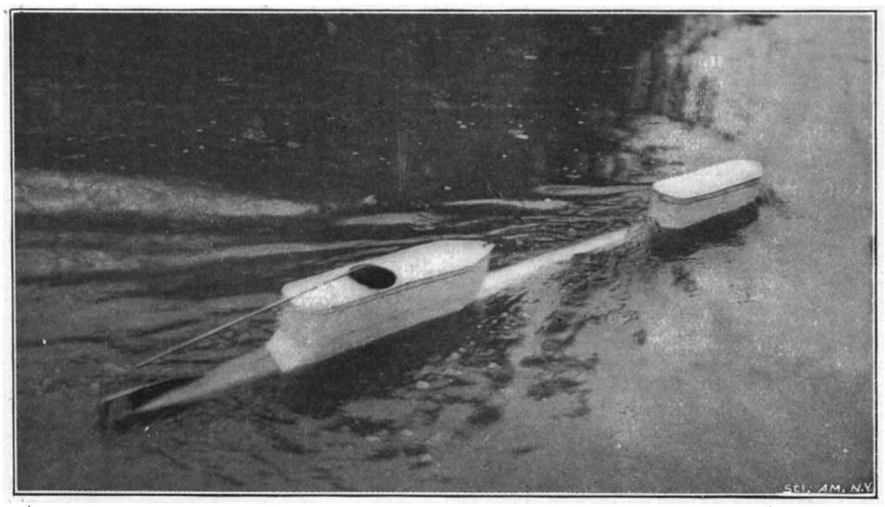
Since we published the description of the Armorl system of wireless telegraphy and process of transmitting electric pulsations from one distant point to another, in a recent issue of the SCIENTIFIC AMERICAN, several important experiments have been made with the apparatus before several prominent electricians and engineers of Great Britain. The naval attachés of the various European governments have also had the practicability and possibilities of the invention demonstrated to them with conspicuous success, and the results of these trials conclusively proved that it will tend to revolutionize certain phases of warfare both on land and sea.

One of the most important contrivances that Messrs. Orling and Armstrong have devised is a new type of submarine boat, which, if necessary, can be controlled from a battleship. Our illustration of the working model of this important arm will best display its salient characteristics. Fore and aft are conning towers, at the base of one of which is the receiving instrument which controls the movements of the rudder. The vessel is equipped with a single screw, which may be driven by any power that may be desired. The importance of this invention is obvious. With the existent submarine vessels the most troublesome factor is the decision of the course which the boat shall take while submerged. Various optical instruments have been devised for the purpose of enabling the commander of the vessel, while traveling under water, to survey the surface and thus to direct his ship in the requisite direction, but so far none of these devices has been found absolutely reliable or practicable. With the Armorl invention, however, the steering is maintained from the conning tower of the battleship to which the submarine is attached. In this instance the commander of the submarine relies entirely upon his superior officer on the battleship for the movement of the submerged craft; and as he is in telephonic or telegraphic communication with the battleship, he is ready to follow immediately any instructions that may be transmitted to him.

In the conning tower of the battleship is a small wheel similar to that utilized for steering the vessel. This small wheel is connected with the Armorl instruments, and as certain movements are made with this wheel certain electric currents are generated which are transmitted to the water by wires and which act in precisely the same way as the two iron stakes utilized in connection with the apparatus upon dry land—the discharge of the electric currents from the transmitting instrument into the sea. Water, however, is a much more sensitive conductor than the earth itself, with the result that the electric pulsations are capable of traveling a much greater distance without losing any of their intensity.

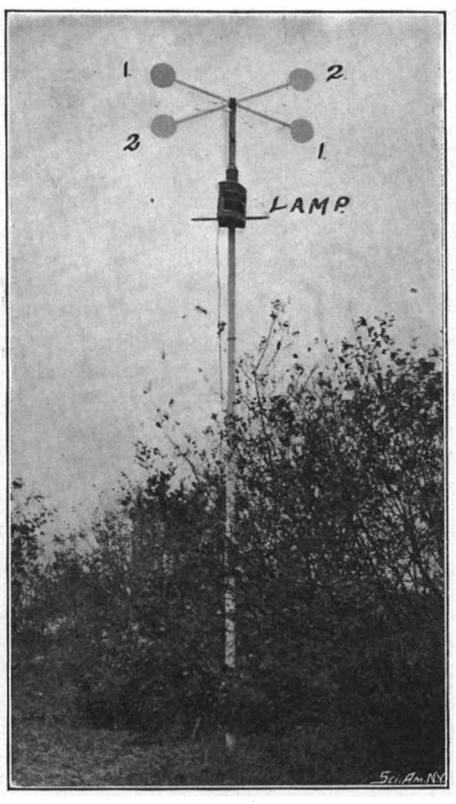
The most prominent feature of this method of electrical communication without wires through water is that no special system of gathering the electric pulsations has to be employed. No matter how deeply the submarine may be submerged beneath the surface, the electro-capillary relay of the receiver within it will feel the effect of the electric discharges in the water, provided of course that the receiver is synchronized to the transmitter. The submarine vessel itself acts as the receiving instrument for the electric waves, which as a rule are arrested at the bow and stern of the craft respectively. In other words, the two extreme points of the boat act as the positive and negative poles respectively. The electric waves travel through the metal hull of the vessel until they reach the electro-capillary relay, the capillary resistance of the mercury within the instrument immediately sets up, and the steering gear of the submarine to which it is attached moves to the degree required by the battleship some miles distant. Not only is the lateral movement of the submarine controlled in this way, however, but the diving and rising motions of the submarine may be manipulated in precisely the same way from a distance if necessary. By this means the submarine vessel is able to continue its journey, being guided from a distance without betraying its presence upon the surface; and the possibility of unexpectedly rising to the surface near the enemy, through error in reconnaissance, is entirely avoided. By means of the wireless telephone or telegraph, the commander of the battleship can keep the captain of the submarine well posted with his course, the distance of the enemy which it is desired to attack, and the psychological moment when to strike, and any other desired information.

One very important feature of the Armorl system is



THE SUBMARINE BOAT TRAVELING ON THE SURFACE WITH CONNECTING ROD FROM ELECTRO-CAPILLARY RELAY TO THE RUDDER, EXPOSED TO SHOW METHOD OF WORKING.

the facility and infallibility of the synchronizing, by which means messages cannot be tapped or interrupted. The receiver and transmitter of each system are tuned to a certain pitch, and it has been continually proved



ELECTRIC LAMP OPERATED BY THE ARMORL SYSTEM.

by the inventors in the course of their demonstrations that no other waves affect a certain receiver unless it is in harmony with the transmitter. Several receivers have been placed at different points, each tuned to a certain distinct pitch. Electric impulses have then been discharged from a transmitter, and the impulses have not affected any of the receivers to the slightest extent in their passage, but have only entered the particular apparatus, the receiver of which was in perfect harmony with the transmitter from which the impulses were discharged. This is a most important factor which will play a prominent part in the success of the invention, since, although synchrony has been secured to a certain degree with the other systems of wireless telegraphy, they have all failed at intervals, thus rendering nugatory their utility. The Armorl instrument, on the other hand, has proved peculiarly successful in this respect. Since there are many gradations of tone to which instruments may be tuned, the possibility of anyone accidentally discovering the particular pitch of an installation and thus intercepting messages is very remote.

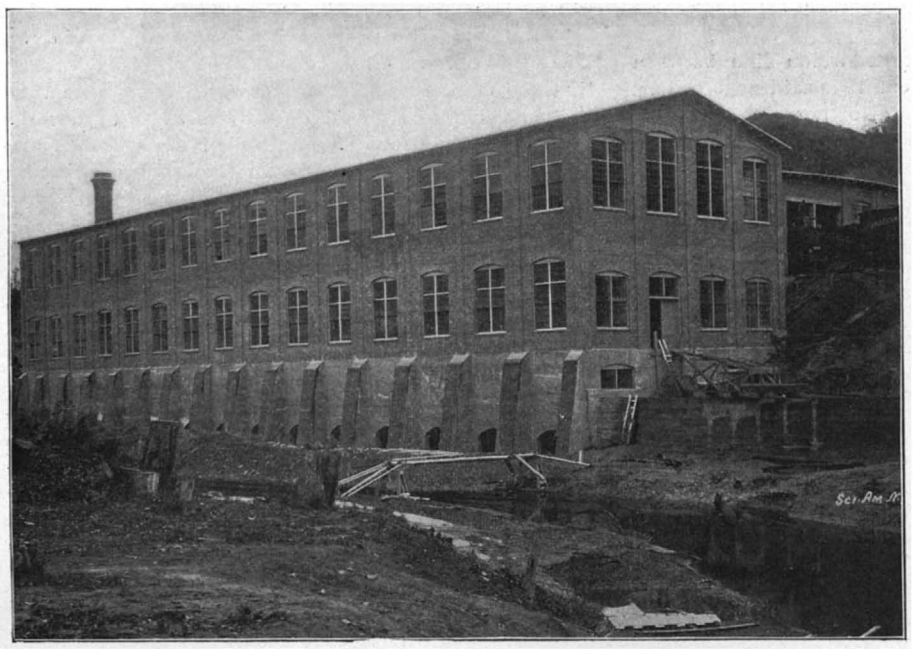
In connection with naval warfare Messrs. Armstrong and Orling have also devised a special torpedo to be utilized in connection with their discovery. In outward appearance it resembles the familiar Whitehead weapon, but its interior arrangements are entirely different. It is approximately six feet in length. The bow is filled with guncotton or other explosive charge, the middle section is occupied by the compressed-air driving engine, and the rear end contains the electrical steering apparatus, comprising the electro-capillary relay, connected to the driving engine. The gyroscope is, of course, dispensed with and the substitution of this intricate mechanism by the Armorl instruments, which are very cheap, results in a considerable economy in the cost of the weapon. It is estimated that the cost of the gyroscopic equipment of a torpedo is about $3,500, or considerably more than half the total cost of the complete weapon.

In the Armorl torpedo steering is not effected by means of a rudder, but by the manipulation of the two propellers with which it is fitted. On the battleship is a small steering wheel similar to that employed with the submarine boat—in fact, the same wheel may be employed—and the movement of this wheel to port or starboard causes either a reduction or increase in the speed of either of the screws upon the torpedo. For instance, if the port screw of the torpedo is reduced to one-half the speed at which the starboard screw is traveling, it will cause the torpedo to wear round to port quickly and easily, and if the starboard screw is manipulated in a similar manner the same result is achieved, only the course is *vice versa*. If the two screws are caused to maintain the same number of revolutions, the weapon will travel in a straight line. Experiments have shown that if a torpedo is operated in this manner, the same effect is produced as if the weapon were equipped with a rudder in the usual way.

If necessary, the compressed-air engines can be stopped entirely, and the torpedo allowed to remain quiescent in the water until a favorable opportunity once more arises for setting it in motion. Or again, under special exigencies, the torpedo could be dropped overboard from the battleship, the latter continuing its journey, and the torpedo started upon its mission at the psychological moment, when perhaps the battleship was some twenty miles distant. It would be as easy to set the torpedo in motion under these conditions as if the vessel were alongside the missile. The Armorl torpedo costs complete $1,000, as compared with $6,000, which is the approximate cost of the latest Whitehead weapon. For military service the invention is appositely adapted for firing mines. The *modus operandi* in this instance is to connect the explosive charge directly with the electro-capillary relay. The mine is buried together with the receiver. The latter is connected with the charge by two short lengths of thick copper wire separated at their lower extremities, which are buried in the explosive. Bridging this gap, however, is a thin hair of copper wire. The electro-capillary relay arrests the electric impulse in its passage through the ground, the electric current passes through the short length of copper wire, and then fuses the thin connection at the lower end, thus detonating the explosive charge. It is a simple operation to fire such a mine, since all that is necessary is to place the two contact screws, projecting from the side of the small box containing the transmitter, in contact with the ground. When the button is

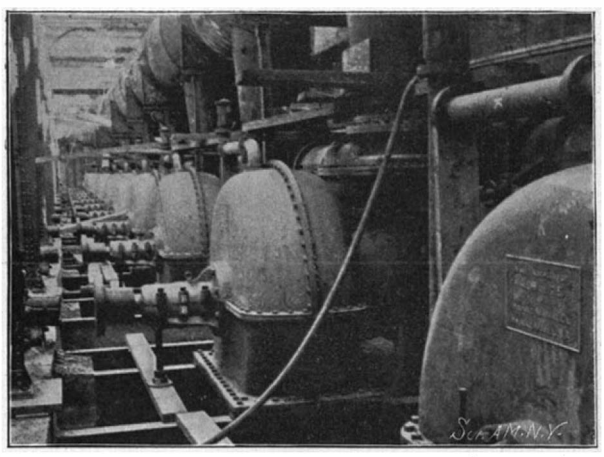
MODEL OF SUBMARINE BOAT CONTROLLED BY WIRELESS TELEGRAPHY.

pressed the electricity flows through the contact screws into the earth and travels to the receiver. No preparations of any description have to be made, and the operation can be readily accomplished from any coign of vantage. The disadvantage of the present



POWER HOUSE OF BELGO-CANADIAN PULP COMPANY—UTILIZING 8,000 TO 10,000 HORSE POWER.

system of land mines is that the presence of the explosive charges is betrayed by the wires on the ground, and, as the war in South Africa has demonstrated, a vigilant enemy can destroy the effect of these mines by crawling up in the dark and cutting the wires. With the Armorl system interruption of the circuit can only be accomplished by the destruction

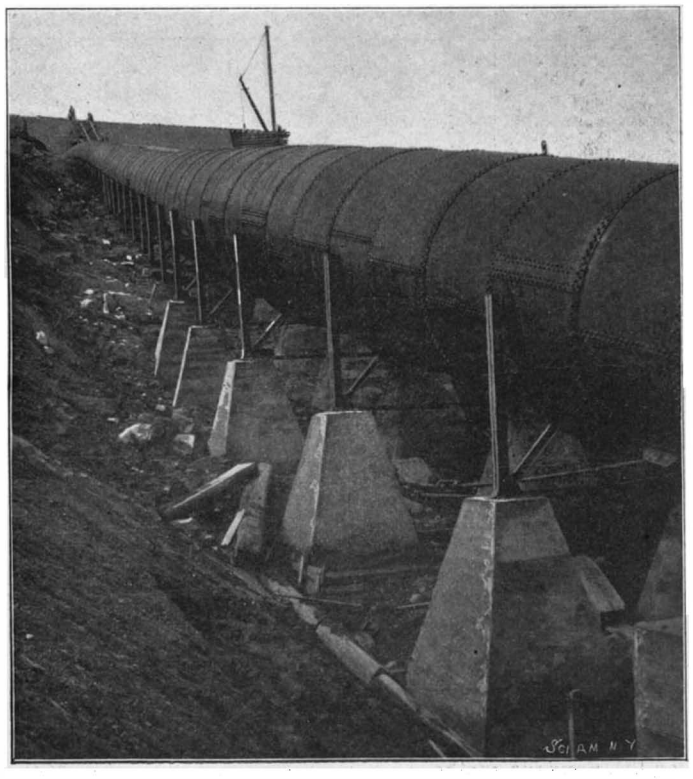


TURBINES OF 8,000 HORSE POWER CAPACITY.

of the receiver or the unearthing of the mine itself, and it would not only be a difficult matter to locate the precise spot at which the charge was buried, but the action of excavating it, even when discovered, would be attended by considerable danger. A vast tract of country might thus be undermined, any one of which mines could be detonated individually, by synchronizing the receiver and transmitter. It might be pointed out that the process of tuning is so simple that a single engineer with one transmitter could fire any number of mines of different tunes, provided he kept a record of the various tunes of the receiver, and adjusted his transmitter accordingly, whenever he wished to explode a particular mine.

While the work of installing the electro-pneumatic system of signaling upon railroads was in progress upon one of the leading trunk roads of Great Britain, the inventors had their attention drawn to the possibility of operating signals by their system. For this purpose an experimental signal was erected at a distance of 1,200 yards from their laboratory, with a view to ascertaining if the idea were at all practicable. At the base of the signal post was placed a small box containing the electro-capillary relay, and connected by wires to two iron rods driven into the ground. From the relay to the arm of the semaphore extended two more wires. Directly the button at the transmitting station was touched the semaphore arm fell, and remained in that position until the transmitter button was again pressed, when it immediately returned to its former position. Since it acted with perfect facility and celerity at 1,200 yards, the inventors repeated their experiments at a distance of five miles with the same conspicuous success. This method of operating signals opens up a vast field in railroad signaling, since it will work to an indefinite distance, possessing none of those limitations inherent to the electro-pneumatic or other processes of actuating signals.

Another important development of the invention is the illuminating of electric lamps. Erected near the top of the experimental signal post is a lamp fitted with two 20 candle power Edi-swan incandescent electric lamps. The transmitter is attached to a battery or accumulator. To light the lamp it is only necessary to depress the transmitting button, and the lamp will remain alight until the battery or supply of electricity is exhausted, or until the key is again touched, when it is immediately extinguished.



PENSTOCK WITH A CAPACITY FOR 5,000 HORSE POWER —9 FEET IN DIAMETER.

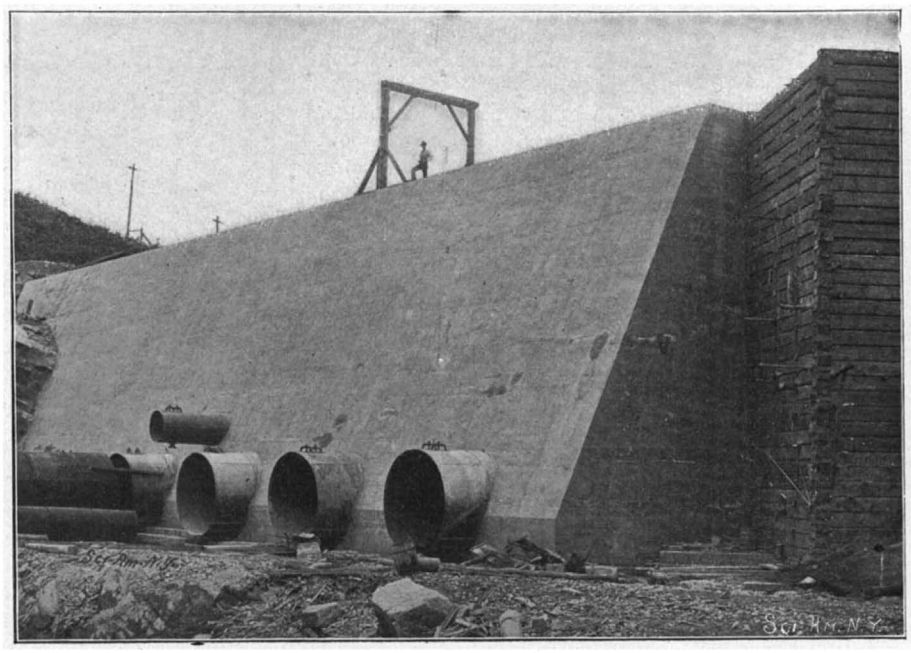
SHAWENEGAN FALLS POWER PLANT.

BY FRANK C. PERKINS.

One of the most important electrical power transmission plants in all Canada is rapidly nearing completion. When it is delivering its full capacity it will undoubtedly supply practically all of the power used in Montreal and Quebec, and will also supply power in the vicinity of Shawenegan Falls to many industrial plants. There is no question but there is a great industrial and commercial future for this little city of 3,000 inhabitants, which two years ago consisted of only a few houses.

The accompanying map shows its location and the general direction of power transmission lines to reach Quebec and Montreal, the former 90 miles distant and the latter 84 miles away. Three Rivers, which is located 21 miles from Shawenegan Falls, will soon have electric service from this power house, as will many of the towns along the Great Northern Railway between Quebec and Montreal. For a number of years the great power of the St. Maurice River has attracted the attention of promoters; but until recently the title to the property and water has been more or less complicated. The Privy Council of England recently decided that the provincial government could dispose of its water powers, and recently it has been selling these privileges with the understanding that the development be immediately commenced.

The Shawenegan Water and Power Company was formed under a charter granted by the provincial government, with the power to develop the water power, manufacture gas and electricity for the purpose of light, heat and motive power, to construct works needed for such purposes, to transmit power generally throughout the Province of Quebec, and to transmit electric power and sell same in the various towns and cities, with the right to expropriate land for its various purposes, including the necessary right of way to any point.



OUTSIDE BULKHEAD, SHAWENEGAN FALLS POWER PLANT, 40 FEET HIGH, 30 FEET THICK AT BASE.

The president of the Shawenegan Water and Power Company is J. N. Greenshields, K. C., of Montreal; the vice-president is John Joyce, of Andover, Mass.; and the treasurer is Mr. J. E. Alfred, of Boston, Mass. For the accompanying illustrations and data in reference to this power plant the writer is indebted to the secretary, Mr. Richard W. Douglas, and the chief

INSIDE PENSTOCK—9 FEET IN DIAMETER.

INSIDE BULKHEAD, SHAWENEGAN FALLS POWER FOREBAY.

engineer, Mr. Wallace C. Johnson, who has had much to do with the Niagara power development during recent years.

The Shawenegan Falls power system obtains its water by a canal 1,000 feet long, 100 feet wide and 20 feet deep. The water is conducted through this canal to a forebay, formed by building a solid concrete wall, or bulkhead, from which the water is conducted through pipes to the power house, 130 feet below. This substantial concrete wall is 40 feet in height and 30 feet in thickness at the bottom. Each pipe, water wheel and generator will produce 5,000 horse power. The water for the operation of the wheel is obtained from the forebay, and is conducted in steel tubes to the power house, each tube having a diameter of nine feet. Three of these penstocks are now in place, and three more are still to be installed and are now under way. The canal has a capacity of 60,000 horse power, and the present development includes a bulkhead for 30,000 horse power, power house and pipe lines for 15,000 horse power, and water wheels and generators for 10,000 horse power.

The company purchased about 1,000 acres of land, of which 200 acres were reserved for mill sites, and about 500 acres for the location of the town, the latter being particularly well adapted for this purpose, being high and comparatively level. The former is an ideal location for manufacturing plants using large quantities of power, both electrical energy and water power privileges being available.

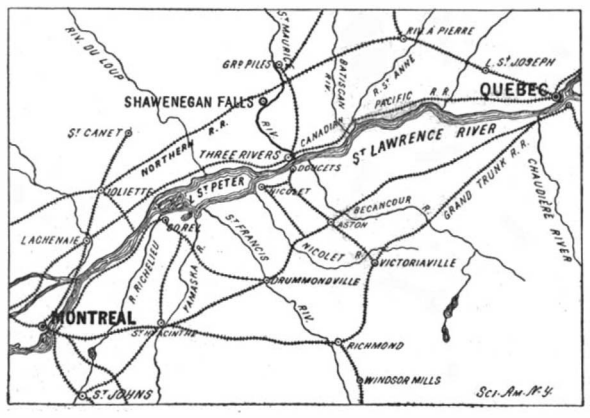
The St. Maurice has a total length of over 400 miles and is supplied from a great many lakes and streams, the drainage area being about 18,000 square miles. The water flow is very steady throughout the year on account of the dense forest covering this area, and is in the neighborhood of 26,000 cubic feet per second. The power which may be developed will not fall short of 100,000 horse power ultimately, and the working head is more than 125 feet.

Besides the main development, it was decided to take advantage of the fact that at one point the Shawenegan River and the St. Maurice came within 1,000 feet of each other, but with a difference of level of 150 feet, and it was here, at a point on the upper bay, a second installation was made. This is about half a mile from the main power station of the Shawenegan Water and Power Company. This installation was built by the Belgo-Canadian Pulp Company, whose enormous pulp mill is supplied with water for operating their turbines by the Shawenegan Water and Power Company. This development consists of a large crib dam through which the water passes at the bottom. The headworks consist of a concrete forebay, which has a height of 40 feet, with the necessary racks and headgates. This solid concrete bulkhead is inside of the crib dam on the bank of the river, and from it the penstocks lead the water through the bank and down to the lower level, discharging into the Shawenegan River as a tailrace, after passing through the turbines. The steel penstock between the forebay and the mill is twelve feet in diameter, and a special tunnel about 200 feet long had to be excavated through the clay bank for its reception. This plant will have a capacity of 15,000 horse power, which is to be utilized by the Belgo-Canadian Pulp Company, but double this power may be obtained by duplicating the crib and bulkhead next to the present one. The present pulp mill will be able to turn out 10 tons of pulp per day, using for this work about 8,000 horse power. An additional 7,000 horse power, making the entire 15,000 horse power, will soon be used by another additional paper and sulphite mill.

The water wheels in the main power house were built by the I. P. Morris Company of Philadelphia and each has a capacity of 6,000 horse power under a working head of 125 feet. Two of these turbines are now in course of erection and two alternating current generators of 5,000 horse power are already installed. These electrical generators were supplied by the Westinghouse Electric and Manufacturing Company of Pittsburg, Pa. There is provision for another 6,000 horse power unit in the present power house; and an addition is provided for duplicating the present plant, which will increase the output to about 36,000 horse power.

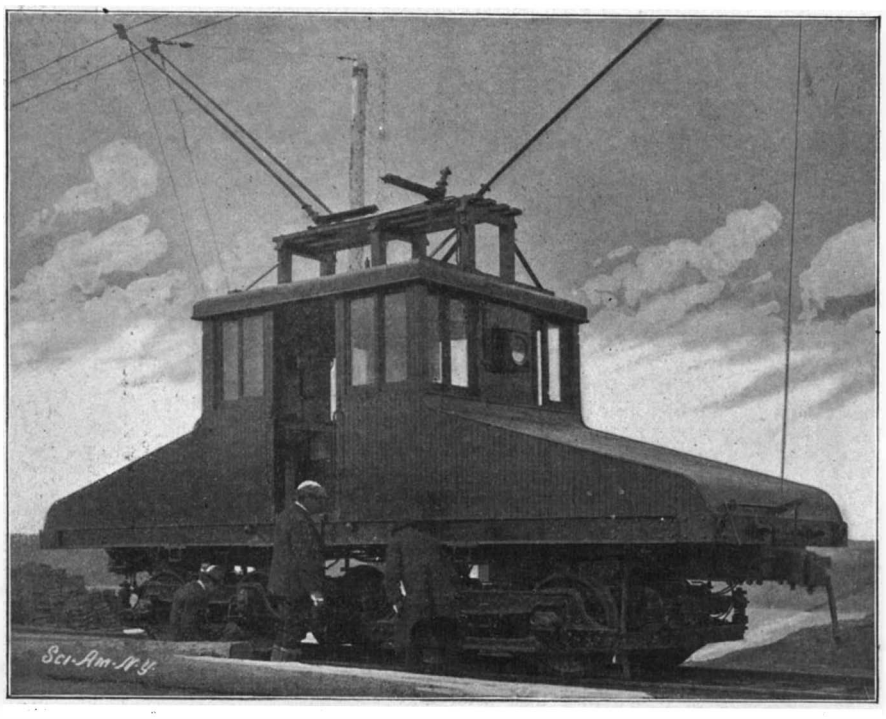
The steel tubing from the forebay to the power house increases in diameter from 9 feet to 11 feet near the turbines, the thickness of the shell of the flume also increasing from 5-16 inch to 9-16 inch. The diagram of the wheels shows them to be of the twin-turbine type, having one runner at either end of the casing. The water enters the turbines radially from without, discharging radially toward the center of the shaft into the draft chambers. The draft chambers connect with an 8-foot draft tube which passes to the tail water. It increases in diameter to 11 feet. The tail water has a low mean level of 25 feet below the center of the wheel shaft. There are two large air chambers above the casing, which is of cylindrical form. The turbine is 30 feet long, and is controlled by gates in the draft chambers. The gates consist of butterfly valves, closing together at the center between the shafts.

In connection with the transmission line between Shawenegan Falls and Montreal, it is said negotiations are under way with the Great Northern Railway and other railroads, whereby the power transmission line will run over their right of way for the greater part of the distance. This would not only lessen the first cost of the transmission lines, but would reduce the maintenance expense to a minimum, while the line in passing the fifteen towns and cities would find many users of the electric current for incandescent lighting and motor service.



MAP SHOWING LOCATION OF SHAWENEGAN FALLS POWER PLANT.

There is little question that quite an industrial center will be established at this power plant. Already the Calcium Carbide Works have been established and a large plant known as the Shawenegan Carbide Company's works has been installed. The Pittsburg Reduction Company's plant is also in operation. The above-mentioned concerns alone will in the near future use about 35,000 horse power. The example of the Pittsburg Reduction Company and that of the Shawenegan Carbide Company is being followed by other users of electrical energy. It is said large plants for the manufacture of bleaching powder, caustic potash and chlorate of potash and other electrolytic works have an exceptional opportunity at Shawenegan Falls.



ELECTRIC LOCOMOTIVE AT SHAWENEGAN FALLS POWER PLANT, USING DOUBLE OVERHEAD TROLLEY.

Novel Smoke Consumer.

M. D'Altoff has invented a smoke-consuming device in which he utilizes the smoke to form a combustible gas which he calls "pyro-gas." The apparatus consists of a kind of filter into which the smoke is driven by a ventilating fan. The filter is filled with porous material such as wood, tow, cotton, coke, etc., and over this is allowed to run a continuous stream of liquid hydrocarbon, petroleum, benzine or alcohol. The result is that a gas is collected from the filter which is rich in carbides of hydrogen, especially ethylene, and thus has a great calorific power. It may be used for heating or to drive gas engines. On the other hand, the filtering matter, which has stopped the soot and the heavy hydrocarbons, may be used as a combustible. In this way the smoke is suppressed and a great economy of combustion is secured. Several plants of this kind are said to have been installed at Brussels, and in one of these the "pyro-gas" is used to heat the boiler of a 50 horse power steam engine. A plant at Malines uses the gas directly with a gas engine of 50 horse power, and several others are to be installed.

The Completion of the Manchurian Railway.

We have frequently remarked, says Engineering, that the engineer is a more powerful personage than the politician, or even the military man. By his works he creates conditions against which these cannot prevail, and hence the necessity for the study of what we have called industrial dynamics. The engineer may call forces into action which upset the calculations of all who confine their attention to merely local conditions. The developments which have taken place in the methods of communication have shrunken the globe into small dimensions, and brought economic conditions to something like equality. We have had many examples of this during the past quarter of a century, and probably the most recent will be the most important. The congratulations which passed between the Czar and M. Witte on the completion of the Manchurian extension of the great Siberian railway were fully justified, not only by the magnitude of the work which had been done, but also because of the results which were certain to follow. While we cannot justify all that has been done in the name of Russian diplomacy, we must confess that a great deal of the criticism which has been made of their work in the Far East has been very unfair. A well-known man recently remarked that the Russians had not taken possession of any territory which was of any use to any other European power; and that if he were a Russian, he would rather die than give up the determination to have a free opening to the Pacific Coast for their vast territories in the north of Asia. It is only ten years since the Czar, then on a tour round the world, cut the first sod of the railway at Vladivostock, and from that time the work has been carried out with an unceasing and tireless energy. The Czar was justified in the warmth of his language to M. Witte, when he said, "I congratulate you on the completion, within so short a time, and amid incredible difficulties, of one of the greatest railway undertakings in the world." We have from time to time given some account of the details of that work; our object now is not to enter into these, but merely to note the completion of a very important section, which is destined to have great economic, industrial, and political results. As originally planned, the terminus of the railway was to be at Vladivostock; but, since the undertaking was entered upon, events in the Far East have added to the scheme. If that scheme had been British instead of Russian, no criticism would have been offered in this country to those developments. The acquisition by Russia, in 1898, of Port Arthur and Talienwan, with the right to connect these places with the main Siberian system by a railway through Manchuria, not only added to the magnitude of the undertaking, but also to its commercial and industrial importance. It is expected when the line is in good working order, and when trains may run uninterruptedly, that the distance between Moscow and Vladivostock or Port Arthur will be covered in about ten days at a fare of $60 for first-class sleeping car. It is also estimated that the journey by the Siberian route from London to Shanghai will take 16 days, and cost $160, instead of the 35 days and $450 involved in the present sea route; but probably this calculation is unduly optimistic. In any case the commercial results must be very marked. No doubt a great portion of the heavy goods will still be sent by sea; but much of the lighter goods and a large proportion of the passengers will go overland. The industrial development of Siberia, however, opens up possibilities which it is impossible at the present time even to imagine. Politically, the railway brings Russia right into the politics of the Far East, and places her practically within striking distance of Pekin. We will not, meantime, attempt to follow the commercial and political results which are certain to follow, but even to superficial observers these must appear to be very great.

Anna C. Draper, who died at her home in Hastings, N. Y., December 10, is said to have been the first woman in the world to have her photograph taken, her brother having invented a process in which a daguerreotype could be made in six minutes. By means of previous methods it took an hour, and no one could pose that long. The original is now in possession of Lord Herschel's heirs in England.

CONSTRUCTING AN EXTINCT MONSTER FROM FOSSIL REMAINS.

BY FREDERIC A. LUCAS.

Our readers have heard much of the remarkable discoveries during the past few years of the huge dinosaurs, whose fossil remains have been found so abundantly in our western territories.

Prof. Clarke, of the U. S. Geological Survey, has long desired to show the public a restoration of a dinosaur and to display one at some of the many expositions in which during the last decade the government has been called upon to take part, and the Pan-American afforded a favorable opportunity.

There were in the U. S. National Museum some fifteen examples of a very curious reptile, called from the horns he bore triceratops, or three-horned-face, and while not a large dinosaur, so far as mere size goes, this was a good example for representation.

It was impractical to use the actual bones for exhibition, hence a model was prepared, which was perhaps more valuable from an educational point of view.

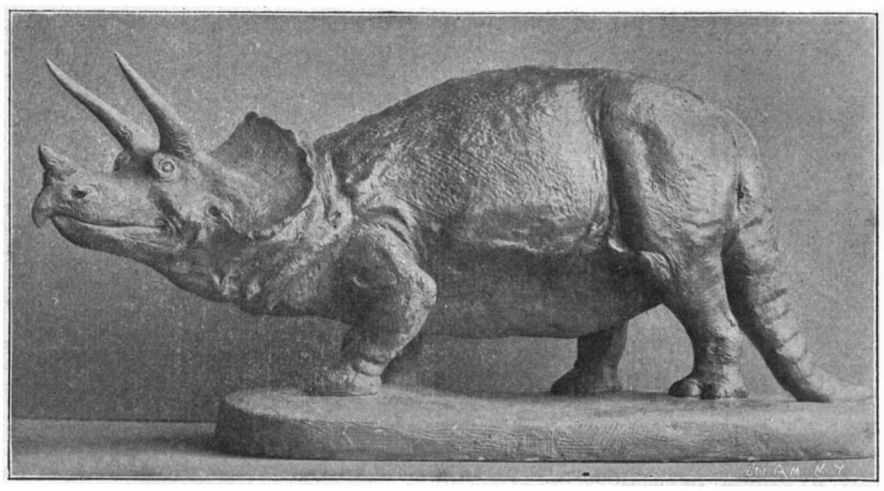
When it was decided to construct a model of a triceratops, it was decided to build it of papier mache, a mixture of paper, plaster, whiting and glue, because this is easily modeled, is harder than plaster, and when worked over a properly constructed framework will stand considerable rough handling, and if broken will merely crack across and not fly into pieces. Each bone was roughly blocked out by a framework of wood, iron rod and wire cloth, and over this was spread a coat of papier mache, which was carefully modeled into the shape of the bone, making straight all twists and turns caused by the pressure to which the original had been subjected. Some of the bones were simple enough, some were decidedly complicated, the head being one of the most difficult, the hip bones the worst of all. For in order to carry their share of the weight of a creature that in life must have weighed at least ten tons, these hip bones had need to be pretty large and very well braced. Moreover, Nature had been economical of material, and, like a good engineer, had chosen to support the weight by a series of cunningly devised struts and trusses, and the two main bones of the pelvis, which rest on the hind legs, were carried by no less than eight sections of the backbone, so that the strains were well distributed. And to reproduce all these bony processes was no easy matter.

Another difficulty was that in spite of the great size of the skull with its spreading frill and massive horns, its various parts were so thin that it was difficult to find a solid spot from which to start. The head was five and a half feet long and four and a half feet wide, and yet the only place that would admit a section of joist six inches square was just at the base of the horns; and from this, as a starting point, supporting irons were carried in every direction to form the framework of the skull.

Borrowing from the methods of the modern builder, the big frill was supported by the twisted steel rods used in the construction of concrete floors, and with the same gain in strength and rigidity. The problem of sustaining the finished skull in its proper relation to the body seemed difficult, but unlike most problems this one solved itself; for it proved that the parts were so well balanced by nature about the junction of the head with the neck that a single heavy pin firmly built into the base of the skull sufficed to carry it. The huge skull, indeed, literally dominates the body; the bones of the neck are directly adapted to its support, while the fore legs are so much shorter than the hind that the creature could readily feed from the ground without the difficulty of lowering and raising half a ton of head for every bite.

Probably the mechanical difficulties in the making of such a restoration as this do not occur to the average observer. To him the modeling of the bones and the correct pose of the various parts seem the serious questions, when, as a matter of fact, these are comparatively simple. The real problem is to so construct the mimic skeleton that it will stand up in good shape with as few visible supports and braces as possible. The sections of the backbone with their various processes might seem much more difficult to reproduce than the ribs attached to them, but quite the reverse is true. To make a rib five feet long, no thicker than one's finger and thrice as wide, curving three different ways, is not an easy matter. It would take a skillful carver to fashion such a bone, and were it done in wood there would be too many weak places where the grain ran crosswise.

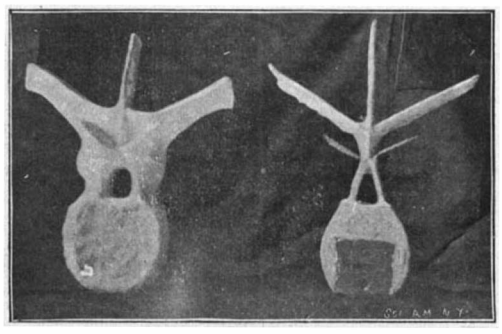
The reclaimed Potomac Flats with their flourishing groves of willows suggested the solution of the rib question, for each rib was outlined with a quarter-inch iron rod and this outline filled with willow withes. The flat body thus formed was wrapped with wire, then with Manila fiber, and lastly given a coat of papier mache in which the little details were modeled, the result being a strong and accurate facsimile of the original. There were twenty-six pairs of ribs in the framework of triceratops. Each vertebra was modeled over such a wood and wire cloth frame as shown in the engraving, but while there were twenty-eight of these sections in the body, and as many more in the tail, no two were alike; each vertebra required a separate form, and each had to fit accurately with the one before and the one behind, and all had to accommodate themselves to the curves of the backbone as a whole.



MODEL OF TRICERATOPS EXHIBITED AT THE PAN-AMERICAN EXPOSITION.

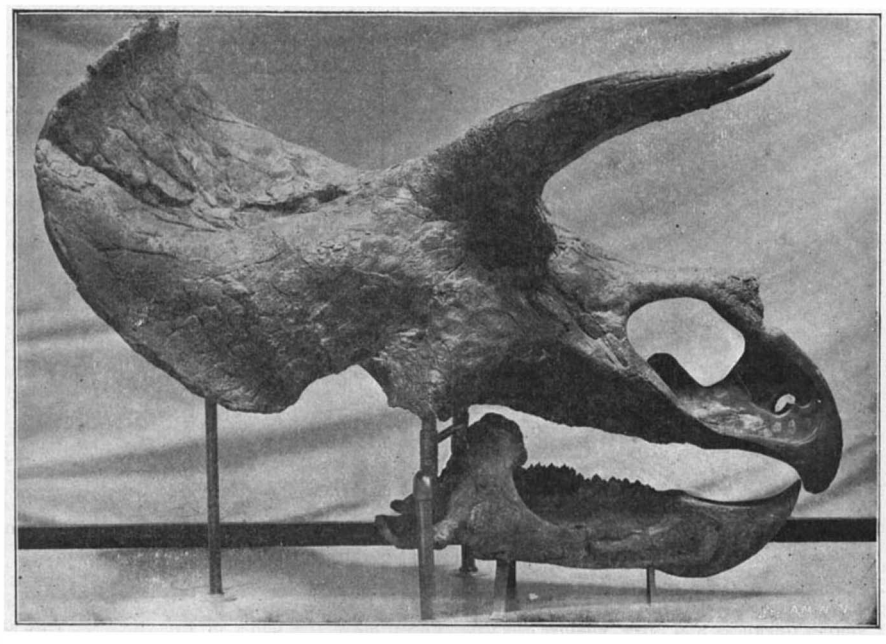
The shape of the leg bones made them easy subjects, both as to internal structure and external modeling. They were made hollow, not only for lightness, but to admit the passage of a heavy pipe that sustained the weight of each leg, while additional strength was gained by running a cross-bar to one of the main supports of the body.

The preparation of this great model was the work of a year, and there were times when it seemed doubtful if it would be done by the time agreed upon; but when the first of May came and the gates of the Pan-American Exposition were formally opened to the public, the model of a triceratops stood complete upon its pedestal just within the north entrance of the Government building. It stood at the highest part ten and one-half feet high, measuring from the tip of the nose to the end of the tail twenty-five feet. The model is now on view at the Charleston Exposition.



SECTIONS OF THE BACKBONE.

There are about 7,000 coin-controlled telephones in China.



FRILL, HORNS AND JAWS.

The Artesian Well Water Supply of Australia.

At the Royal Colonial Institute of London Mr. W. Gibbons Cox, C.E., delivered an interesting lecture upon the supply of water by means of artesian wells in Australia. Australia, despite its national wealth and resources, has always been subject to one great drawback: that of occasional droughts of greater or lesser severity, due to the peculiar physical character and conditions of the country. Owing to the comparatively low altitude of the existing ranges, the watersheds of Australia are less effective than those in countries possessing high mountain chains. Another condition which militates against the formation of a river system is the absorptive nature of the soil. At flood times there are long stretches of navigable waters in the interior; but in time of drought those rivers and creeks exist in name only, because soakage and evaporation reduce them to a mere chain of waterholes. The natural sources of the water supply are those from the rainfalls, the rivers, the creeks, lagoons and waterholes in the interior, and the subterranean stores, the latter having been utilized only within the last few years. A very large portion of the rain, the source of supply, sinks out of sight into the earth in so imperceptible a manner that the quantity of it fails to impress itself on the mind. Even the hardest rocks are to some extent porous, and granite itself has a percentage of water in its composition. All the softer rocks are water bearing and the dense, compact limestones frequently hold great quantities of water in cavities and cavernous galleries. The cretaceous formation is freely developed in Western Australia, South Australia, New South Wales, and Queensland. In Victoria, so far as is known, are artesian wells to a lesser extent. Considerable work has been done in the various States in drawing the water supply from these artesian wells, both by the government and by private landholders. The largest number of these bores is to be found in Queensland, owing to the territory being in an exceptionally favorable position for the fulfillment of the conditions required for a supply of water. The rainfall is caught on the western slope of the dividing range, from which almost the whole country to the border slopes downward. In Queensland the water-bearing sandstones have been proved to be over 700 feet in thickness. The depth of the bores varies from 300 to 5,000 feet. The total number of bores in Queensland is 839, of which 6 per cent only have been made by the government. There are 60 flows of over 1,500,000 gallons per day, ranging as high, at Cunnamulla, as 4,500,000 gallons, and at Coongola to 6,000,000 gallons a day. The continuous yield from 515 flowing bores is 321,653,629 gallons per day. Some of the water issues at a high pressure of which use is made in various ways. In a few of the bores the temperature of the water is high, in one case being 196 deg. Fahrenheit. This artesian water has been the salvation of stock to the value of millions of dollars, and when the immense water-bearing areas hitherto subject to drought have been further tapped the saving in future years would be enormous. In connection with the irrigation from rivers, the Darling-Murray system, which never runs dry, has proved the best.

Influence of Hydrogen on Iron.

The influence of hydrogen upon iron forms the subject of a series of experiments made in the Charlottenburg technical laboratory by E. Heyn. The gas is allowed to act upon iron at red heat, and it is found that the latter is considerably affected. In the first experiments he found that iron heated to redness and plunged in an atmosphere of hydrogen, then tempered in water, became brittle, and that this brittleness is especially remarked in the trials of cold bending. On the other hand, if the iron is again heated at a rather low temperature in a water or oil-bath it becomes much less brittle or even regains its original state. The same phenomenon is observed when the pieces are allowed to remain in the open air at the ordinary temperature. The time required for the iron to come back to the normal state varies with its constitution. For instance, samples of Martin steel of 0.05 carbon took fifteen days to come back. In the case of steel wire one-eighth inch in diameter and very poor in carbon the time is much longer.

The Lehigh University will offer a new and extended course in electro-metallurgy, beginning next fall. This is the first of its kind in the country.

RECENTLY PATENTED INVENTIONS.

Agricultural Implements.

PLOW.—BENJAMIN D. BALDWIN, Maui, Hawaii. The invention is a double moldboard hilling-up plow, so constructed that it will throw up a large amount of loose soil against the stems of sugar-cane or other growing crops planted in rows. The plow is simple and durable.

COMBINED WIRE-FENCE MACHINE AND STALK-CUTTER.—FRANK SCHMITT, Carlyle, Ill. The purpose of this invention is to provide a machine of improved construction which can be drawn along and made to pay out wire during the building of wire fences, and which will be adapted to reel in fence-wire removed from the posts. The device can likewise be used to collect and cut up stalks.

Engineering Improvements.

STEAM-BOILER.—WILLIAM N. OLDMAN, 270 Front Avenue, Buffalo, N. Y. Rows of fire-tubes are arranged horizontally and equidistantly; and between each two rows of fire-tubes rows of threaded stay-rods are arranged both vertically and horizontally. The arrangement of the stay-rods in rows between two vertical and horizontal rows of tubes insures uniform distribution of strain, so that cracks and leaks are not liable to occur and a maximum strength is obtained. The inventor claims that his boiler can withstand nearly double the pressure of steam of cylindrical fire-tube boilers having stay-rods arranged in the usual way.

Metallurgical Apparatus.

MACHINE FOR EXTRACTING METAL FROM ORE.—ALBERT I. IRWIN, Cripple Creek, Col. The object of the invention is to provide a simple mechanical device to be used in conjunction with any suitable solution and an electric current for the continuous and the automatic treatment of the metals, the precious metals being simultaneously extracted and deposited. In a treatment-tank, an endless anode travels, the upper and lower stretches of the anode being in position to be immersed in the solution in the tank. Diagonally-disposed blocks of insulating material are attached to the anode. Under each stretch of the anode in the tank is a cathode.

AMALGAMATOR AND CONCENTRATOR.—IRWIN H. SPRIGGS, Eureka, Utah. The ore amalgamator and concentrator comprises two semi-cylindrical trays arranged one above the other and supported on rockers. Water is supplied to the upper tray. An agitator in the lower tray is operated by the rocking movement of the tray. An automatically operated valve is provided for an outlet in the lower tray. By reason of the peculiar rocking motion, all earth that can be worked by other machines is successfully handled. The machine's chief success, however, lies in saving values in clay.

ORE-LEACHING APPARATUS.—RALPH L. GRAVES, Sumpter, Ore. The invention is an improvement in apparatus for use in separating ore. Means are provided whereby the pulp is agitated through the medium of a suitable pump, the suction and discharge of which can both be within the same tank. By means of this apparatus, agitation can be stopped and resumed at pleasure. The clear fluid can be drawn from the agitation-tank when desired. But little power is required.

Mechanical Devices.

MACHINE FOR MAKING PLASTER-BOARDS.—PATRICK RYAN, Manhattan, New York city. In July, 1900, Mr. Ryan patented a machine for making plaster-boards. The present invention is an improvement on that machine. The machine is designed to form fire-proof boards for use in buildings, the boards beng produced from alternate layers of a suitable fabric and a plastic material such as ordinary plaster. A hopper contains the dry plaster; and an apron passes therefrom. The apron moves through a water-pan or trough to wet the plaster. A second apron, movable transversely to the first apron, is adapted to carry webs of fabric in which the wetted plaster is deposited. The material is spread on the fabric-web by a spreader working over the second apron.

WOOD-TURNING LATHE.—DEFIANCE MACHINE WORKS, Defiance, Ohio. This machine, the invention of Mr. George A. Ensign, is especially designed for producing in large quantities duplicate articles—such as bobbins, handles, spoons, mallets, stakes, pins, and the like, either plain or with beads—the lathe being arranged to reduce the rough material to the finished product complete in every respect and the exact shape and size, perfectly smooth and highly accurate. The lathe consists of a spindle carrying a number of cutters, toward and from which a table is mounted to travel transversely. On the table a head-stock is mounted. A driving-pulley mounted in a swinging support carried by the table is geared with the head-stock. The tail-stock is also mounted on the table; and means are provided for operating the table.

STAPLING-MACHINE.—MILTON HINKLEY, Benton Harbor, Mich. The invention relates to machines for making baskets. The construction is such that the work can be readily shaped over a former without hindrance from the staple-driving devices. When the work is shaped the staple-forming and staple-driving devices are brought into an active position over the work and the former, to secure the parts of the work together by means of the staples.

MEASURING-FAUCET.—JOHN P. DOBBYN, Hayfork, Cal. This faucet is particularly useful in dispensing soda water, tea, coffee, or other beverages, and is so arranged as to discharge the proper amount into a tumbler or cup. The device is operated without touching the faucet, which is often hot.

CIGARETTE-CUTTER.—FELIX P. HERMIDA, San Juan, Porto Rico. The machine cuts cigarettes from the lengths received from the cigarette-forming machine. And the object is to provide a cutter so constructed as to travel with the movement of the cigarette-length leading from the forming-machine, thus making a straight cut without danger of tearing the paper.

CALCULATING-MACHINE.—CLARENCE E. LOCKE, Kensett, Iowa. The calculating-machine is of the Young-Fowler type, in which a number of independent slides are used. The present invention provides a calculating-machine of this class which is simple and durable; which exhibits the result in such a place that there will be no possibility of confusion nor any necessity for changing the position of the machine to find the result; in which a simple mechanism is furnished for locking the slides when desired, and in which the slides are distinguished so as to facilitate calculation.

BOTTLE-CARRIER.—WILLIS D. SNOW and HARRY M. PALMER, Bloomington, Ill. The inventors have devised a novel machine for assembling a number of jars or bottles, so that they can be carried hanging with open mouths for immersion into a tank holding liquid for filling the bottles or jars. The invention is especially adapted for filling milk-jars in quantity at one operation.

BALL MIXING AND DISCHARGING APPARATUS.—CHARLES DUHAMEL, Rue le Peletier 11, Paris, France. Given a number of balls in a suitable receptacle, to cause the balls to pass from the receptacle in a certain number of outlet tubes leading to stopping or distributing devices—this is the problem which the inventor has solved. A receptacle is used, in which the balls can be inserted, and which is provided with a bottom made in two parts, one of which is fixed and the other movable. On the edge of the fixed part, adjacent to the movable part, are perforations communicating with the outlet-channels. The movements of the movable parts are sufficient, relatively to the sides of the receptacle, to cause at certain moments the greater part of the balls to come together at the lower parts of the receptacle, and leave only a slight layer of balls on certain inclined parts of the bottom. The result is that these latter balls are free to roll toward the outlets.

FIRE-ESCAPE.—THOMAS T. BROWN, Angus, Minn. The fire-escape is provided with a coil of rope which is held in a suitable casing. Mechanism is provided for causing the rope to run slowly out of the casing; so that by fastening the outer end of the rope a person can connect himself with the casing and gradually descend from a burning building.

Vehicle Accessories and Harness.

MEANS FOR RESTRAINING HORSES.—SAMUEL S. STEWART, Hicksville, N. Y. This invention relates to a device for arresting runaway horses; and it comprises two knobs arranged to be pressed against the nozzle of a horse to throttle it whever it runs away.

FIFTH-WHEEL.—GEORGE BENJAMIN, Saginaw, Mich. The fifth-wheel comprises a pair of annular members provided with threads loosely screwed together. One of the members is provided with means for connecting it with the front axle of the vehicle; and the other annular member is provided with means for connecting it with the bed of the vehicle. The fifth-wheel is simple, durable, easy to operate, and made up of parts easily interchanged. It is adjustable; and its parts are readily accessible.

Miscellaneous Inventions.

ENVELOPE OR SACK.—CHARLES A. MEADOWS, Yonkers, N. Y. This new and improved sack is designed for receiving coins, paper money, and other articles, and is arranged to be conveniently opened to permit the discharge of the contents and then to form an advertising medium.

NAPKIN-HOLDER.—ALEXANDER H. BROWNLEY, Onehunga, Auckland, New Zealand. The holder is designed to support a table-napkin over the clothing at the front, and is also adapted to hold a napkin in folded position on the table, thus dispensing with the usual napkin-ring. The holder can be quickly applied to the napkin and to the cloth without danger of cutting the material.

CARD OR PHOTOGRAPH HOLDER.—LUCIEN E. PARKER and JOHN S. GOTT, Lenox, Mass. The clamping device provided by these inventors is capable of engaging a card, photograph, or the like, without perforating or bending the article. The device permits a number of photographs to be strung in series or to be arranged in groups or any other desired order, permits the use of cards of different shapes, thickness and sizes, enables the user to place a stack of photographs or group them together in one place without having vacant holders left over, and provides for the easy removal of any card or photograph without disturbing other cards. When a number of photographs are to be stored away the improved holder can be folded upon itself, so as to allow the photographs to be arranged face to face.

SMOKE-PIPE REGISTER.—WILLARD S. TUTTLE, Brooklyn, New York city. The invention relates to heating-drums or smoke pipes usually extending from a room through the ceiling and the floor above into an upper room and connecting with the chimney to carry off the smoke and gases, and to radiate heat into the room above. The invention provides a new and improved register for holding a smoke-pipe in position in the floor and arranged for obtaining the desired control of the heated air passing from a room below to the room containing the register.

TRUNK.—FRITZ C. LUNDBECK, San Francisco, Cal. The trunk is arranged with a number of drawers located one above the other to fill the trunk body completely. The construction permits the independent use of the drawers, so that the owner can readily gain access to any of the drawers without disturbing the positions of the other drawers.

DRAWING-TABLE.—HENRY A. DAVIS, Muskegon, Mich. The drawing table comprises a standard on which is a head. The table-top has a plate pivotally connected with the head. A segmental flange is extended outward from one side of the plate; and a locking-bolt is movable through the head and has a hook portion to engage over the flange. The table is simple, cheap, and readily adjustable to any height and incline.

PAPER-BAG HOLDER.—CHARLES F. FRANCISCO, 719 Fifth Street, San Diego, Cal. The invention is an improvement in devices adapted to hold paper bags and the like for use in grocery, confectionery and other stores. The devices are so constructed and arranged as to permit a single bag to be removed from the pack or bundle without disturbing the others.

CHECK-BOX.—THOMAS F. MCCULLOUGH, Memphis, Tenn. The box holds and successively delivers consecutively-numbered checks. The device is adapted specifically for use in barber-shops, physicians' offices and hospitals where customers, clients, or patients are served in their turn. By means of the device each person, on entering the waiting room may secure a check; and these checks, running consecutively as they do, will settle all disputes concerning the time of arrival.

PUZZLE.—MARY F. BOUGHNER, Sedalia, Mo. The puzzle includes a board consisting of a box-like casing, and a cardboard false bottom provided with holes arranged in the form of a cross. The holes are marked and are designed to receive pins. The idea is in setting the puzzle to place a pin in each of the sockets except the central one, then by jumping from any of the four sides into the central hole, removing the peg, which is jumped and continuing to jump one peg at a time until only one peg is left on the board, and that in the center.

PAD FOR SUPPORTING PRINTING-FILMS.—BENJAMIN DAY, West Hoboken, N. J. The pad supports a printing-film while it is being inked and presents a semi-rigid and evenly-yelding support for the printing-film, while the latter is under the pressure of the flexible-composition hand-roller that is passed over it during the operation of inking the film. The present pad is an improvement on the plane surface hitherto used in supporting the film during the inking process, and readily accommodates itself to the action of the flexible-composition roller in passing over its printing surface without inking the interstices or intaglio parts surrounding the tints, in relief.

ADJUSTABLE SLEEVE-CHART.—HARRY C. WILSON, Manhattan, New York city. The pattern for sleeves is of such a character that it can be quickly adjusted to the desired measurements. The sleeve pattern is so constructed as to give upon its outside the pattern of the top part of the sleeve and with its inner outline the pattern of the under part of the sleeve.

Designs.

CASE FOR VENDING-MACHINES.—MILBERT F. PRICE, Iowa City, Iowa. The leading feature of the design is a base with a vertically-extending transparent cylindrical case mounted thereon.

DIE SECTION.—EDWARD H. SMITH, Mt. Vernon, Ohio. A design patent has been granted to H. E. Smith, for a die section for use in the forming of sheet metal articles, which design is characterized by longitudinal curved grooves arranged side by side with an intervening partition, the walls of the grooves being provided with transverse grooves which lead to the outer edges of the curved grooves, the whole aiding in securing the form of article desired.

MERCHANDISE CHUTE FOR VENDING-MACHINES.—MILBERT F. PRICE, Iowa City, Iowa. The chute has a body portion with widened end parts and is to be used in connection with the collar-button-vending machine recently patened by Mr. Price.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

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Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 1863.—For manufacturers of novelties for the mail order business.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 1864.—For the M. E. Hall hemstitcher or a substitute thereof.

WATER WHEELS. Alcott & Co., Mt. Holly, N. J.

Inquiry No. 1865.—For wholesale manufacturers of door locks.

Stencil Machines.—A. J. Bradley, 101 Beekman St. N.Y.

Inquiry No. 1866.—For dealers in second-hand gasoline engines.

Metal substitute. Crane Bros., Mfrs., Westfield, Mass.

Inquiry No. 1867.—For manufacturers of the wireless telegraphy apparatus.

Gasoline Lamps and Systems. Turner Brass Works, Chicago.

Inquiry No. 1868.—For mechanical drawings on small dynamos and engines.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 1869.—For a machine for tying rattan in bunches.

Bids accepted for whole or part of U. S. Patent No. 688,235. Box 2, Kent, N. Y.

Inquiry No. 1870.—For parties to make a screen door fastener.

Glass paper-weights for advertising. Write for prices. Lobmiller Co., Wellsburg, W. Va.

Inquiry No. 1871.—For machines for making light barrels and kegs.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 1872.—For manufacturers of ground paper for making papier maché.

Rigs that Run. Hydrocarbon system. Write St. Louis Motor Carriage Co., St. Louis, Mo.

Inquiry No. 1873.—For manufacturers of silvered glass or mirrors for reflecting telescopes.

FOR SALE.—New patent for boiler No. 684,620. J. Snyder, 254 Wythe Ave., Brooklyn, N. Y.

Inquiry No. 1874.—For manufacturers of collapsible tubes.

For sheet metal stampings and novelties try Standard Stamping Co., Seventh and Hudson, Buffalo, N. Y.

Inquiry No. 1875.—For manufacturers of mailing cases for grease tubes.

If making metal goods and needing special parts, write us. Metal Stamping Co., Niagara Falls, N. Y.

Inquiry No. 1876.—For blocks for cutting out gloves and mittens.

Ten days' trial given on Daus' Tip Top Duplicator. Felix Daus Duplicator Co., 5 Hanover St., N. Y. city.

Inquiry No. 1877.—For rubber-tired casters 2½ inches to 3½ inches in diameter.

FOR SALE.—The patent right of a good-selling portable commode. Address Saunders Bros., Westerly, R. I.

Inquiry No. 1878.—For hydraulic jacks affording 12 inches raise and capacity of 500 pounds.

Inventions developed and perfected. Designing and machine work. Garvin Machine Co., 149 Varick, cor. Spring Sts., N. Y.

Inquiry No. 1879.—For rough and finished green and plate glass slabs ⅛ inch and 1 inch thick, and about the size of 12 inches by 24 inches, 18 inches by 22 inches, 40 inches by 22 inches and 76 inches by 22 inches.

Manufacturers of patent articles, dies, stamping tools, light machinery. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 1880.—For manufacturers of hydraulic, electric or steam cranes.

Designers and builders of automatic and special machines of all kinds. Inventions perfected. The W. A. Wilson Machine Company, Rochester, N. Y.

Inquiry No. 1881.—For manufacturers of iron bars, steel-laid for wood planer knives.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Refrigerating Machine Company. Foot of East 138th Street, New York.

Inquiry No. 1882.—For knives for rotary and other veneer machines,

The best book for electricians and beginners in electricity is "Experimental Science," by Geo. M. Hopkins. By mail, $4. Munn & Co., publishers, 361 Broadway, N. Y.

Inquiry No. 1883.—For an apparatus for cooling a cold storage room.

Have completed a series of high-grade Microscope Objectives of entirely new and improved formulas. Do my own work throughout. Am seeking position where can continue or superintend manufacture of the same. Genuine opportunity for enterprising establishment. Dadd, 350 Seventh St., Buffalo, N. Y.

Inquiry No. 1884.—For ice-making plants.

☞ Send for new and complete catalogue of Scientific and other Books for sale by Munn & Co., 361 Broadway, New York. Free on application.

Inquiry No. 1885.—For machines for cutting out of quick lime pencils which are to be used for calcium lights.

Inquiry No. 1886.—For manufacturers of cabinet handles made of thin brass or nickel.

Inquiry No. 1887.—For manufacturers of machinery for making rugs from old carpets.

Inquiry No. 1888.—For parties engaged in embossing work on stationery.

Inquiry No. 1889.—For manufacturers of heavy flat coil springs.

Inquiry No. 1890.—For dealers in cut gearing.

Inquiry No. 1891.—For manufacturers of spice mill machinery.

Inquiry No. 1892.—For manufacturers of adding machines.

Inquiry No. 1893.—For parties handling the "Martin Cash Carrying Device."

Inquiry No. 1894.—For machinery for making butcher skewers.

Inquiry No. 1895.—For a steam-meter (Kalorimeter) Prof. Peabody's system, or the manufacturer thereof.

Inquiry No. 1896.—For parties to manufacture a mail pouch catcher and deliverer.

Inquiry No. 1897.—For manufacturers of telephone supplies.

Inquiry No. 1898.—For parties to manufacture gas mantles.

Inquiry No. 1899.—For parties to spin a certain material into thread for making mantles.

Inquiry No. 1900.—For a hydraulic press with accumulator and pump combined.

Inquiry No. 1901.—For manufacturers of motor bicycles for road riding.

Inquiry No. 1902.—For manufacturers of merry-go-rounds.

Inquiry No. 1903.—For manufacturers of magical apparatus.

Inquiry No. 1904.—For manufacturers of crude oil burners for steam boilers.

Inquiry No. 1905.—For freight automobiles to carry about 2,000 pounds.

Inquiry No. 1906.—For manufacturers of fulling machines and textile machinery.

Inquiry No. 1907.—For manufacturers of the Regal motor gasoline engine.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending

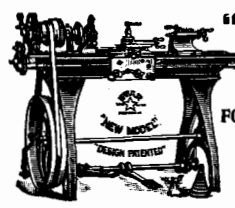
January 7, 1902,

AND EACH BEARING THAT DATE.

[See note at end of list about copies of these patents.]

Accounts, system of keeping, E. R. Edwards 690,708
Acetone, making, J. L. Hawliczek 690,724
Air conducting tube, F. Line 690,744
Auricular instruments, transmitting and receiving tube for, A. G. House 690,430
Autographic register, T. F. Schirmer 690,465
Automatic brake, M. A. Beck 690,552
Awning, C. H. Hansen 690,650
Axle shaping machine, G. A. Ensign 690,709
Bag. See Laundry bag.
Bag machine, G. R. Ward 690,491
Bag or satchel lighting device, W. W. McCormick 690,753
Ballast conveyer and leveler, G. F. Spurlin 690,788
Battery end cell switch indicator, A. C. Walther 690,800
Battery plate, secondary, B. Kuettner 690,589
Bearing, electric motor shaft, S. H. Short 690,467
Bearing, roller, F. W. Thomas 690,484
Bearing, roller, F. Whitney 690,626
Bed and invalid chair, combined spring, J. H. T. Edwards 690,844
Belt, J. Loeffelholz 690,863
Bicycle, H. Jarvis 690,733
Bicycle seat, H. Jarvis 690,734
Bicycle support, V. M. Gabrielle 690,718
Billiard cue bridge, S. Ruhland 690,617
Billiard cue tip, F. L. Robinson 690,613
Binder, H. H. Hoffmann 690,859
Binding or edge protector and making same, skirt, A. S. Kronold 690,442
Bismuth oxyiodid methylene digallate and making same, S. L. Summers 690,672
Bismuth oxyiodids, making methylene digallate of, S. L. Summers 690,673
Blacking or coloring boots or shoes, device for, F. Gibberd 690,850
Block or tile for partitions, wall s etc., W. A. C. Waller 690,811
Boat, life, A. Anrep 690,685
Boat, life, R. D. Mayo 690,909
Boiler, C. J. Cronin 690,701
Boiler setting, G. L. Norrman 690,870
Boiler tube cleaner, M. Snyder 690,474
Bottle filling and capping machine, T. L. Valerius 690,488
Bottle, non-refillable, O. E. Blaine 690,631
Bottle top, tooth powder, H. B. Kent 690,737
Bottle washing machine, W. B. Cobb 690,563
Boxing machine, F. W. Wild, Jr 690,805
Bracelet, elastic chain, J. Kun 690,590
Brake, T. G. Blatch 690,692
Brake beam, J. H. Baker..690,547, 690,548, 690,824 to 690,826
Brake block for vehicles, adjustable, N. Liston 690,745
Branding animals or packages, apparatus for, Renner & Boyens 690,771
Bread or cake box, J. Powers 690,874
Brick making machinery, H. Hanni 690,857
Brooder, J. M. Sontag 690,885
Broom, W. H. O'Keefe 690,871
Broom, etc., hanger, J. F. Whitehead 690,803
Broom head, J. H. Webb 690,495
Broom head, H. W. Judevine 690,736
Buffing machine, M. H. Ballard 690,548
Buggy top, folding, J. A. Wilson 690,543
Bung, R. Spahn 690,786
Bunsen burner, C. W. Taylor 690,792
Burner. See Bunsen burner.
Button or stud, attaching, C. H. Schopbach 690,666
Calendar, F. C. W. Stelter 690,670
Calipering device, sheet, T. C. Dexter 690,703
Call apparatus, electric, C. Shore 690,623
Camera panoramic attachment, H. L. Fisher 690,570
Can filling device, F. Strattner 690,790
Can heading machine, automatic, A. W. Livingston 690,593
Can opener, G. W. Gomber 690,418
Candelabrum, J. G. Theobald 690,538
Cane, S. A. M. Khan 690,655
Car brake, S. H. Pocock 690,769
Car checking device, A. M. Acklin 690,814
Car coupling, L. N. Singin 690,470
Car coupling, J. M. Clark 690,560
Car coupling draw bar draft rigging, J. M. Waugh 690,683
Car draft rigging, railway, J. M. Waugh 690,684
Car, dump, Williamson & Pries 690,501
Car, dumping, J. C. & R. A. Sturgeon 690,625
Car emptying mechanism, J. M. Riddle 690,877
Car fender, J. H. Surtin 690,674
Car, metal freight, L. T. Canfield 690,559
Carbonometer, E. S. Downs 690,409
Carbureter, Lane & Davenport 690,444
Carbureting apparatus, air, P. R. van der Made 690,681
Cards, machine for lacing jacquard, V. Royle 690,615
Cash register, Smith & Giles 690,472
Cash register, F. H. Bickford 690,554
Cash register, J. P. Cleal 690,561, 690,562
Ceiling, J. Freckmann 690,646
Cement, strengthened cast, J. Daime 690,840
Chain, halter, S. M. Wells, Jr 690,801
Chatelaine holder, T. H. Fishel 690,569
Chimney thimble, C. F. Schroth 690,778
Cigarette machine, C. R. Spencer 690,887
Cinematographic apparatus, F. Alberini et al 690,815
Clasp, N. Crane 690,904
Clothes line reel, P. Krex 690,588
Clothes line tightener and adjuster, Blevins & Taylor 690,890
Clutch, automatic, G. S. & J. J. Huff 690,583
Clutch, traction engine friction, P. Swenson 690,536
Cock for water heaters, combined gas and water, W. B. Folger 690,413
Coffee hulling machine, A. H. Hopkins 690,429
Coin controlled apparatus, fraud preventing device for, O. E. Sorg 690,476
Coin holder, J. Williams 690,806
Coin weighing and counting machine, C. W. Reeves 690,876
Coke oven, R. D. Martin 690,748
Collar, horse, H. J. Breeze 690,632
Commode, J. B. Frost 690,415
Combination wrench, C. J. Barnes 690,688
Commutator brush, C. G. Curtis 690,516
Compound engine, telescopic, W. Schneider 690,620
Condenser and water heater, tubular, C. P. Horton 690,729
Conveyer, A. J. Frith 690,518
Cooking utensil, E. S. Oliver 690,760
Cooling and ventilating apparatus, J. & W. Titus 690,485
Cop tube carrier, S. W. Wardwell 690,493
Corset, apparel, C. H. Schopbach 690,665
Corset, extensible, F. C. Smith 690,898
Corset shaping machine, S. Kons 690,740
Cotton cleaner, J. T., W. R. & G. B. Rodgers 690,614
Counter, H. R. Heal 690,424
Cover retaining device for pots and kettles, C. D. Brown 690,828
Crane for handling lumber, etc., H. Brooke 690,513
Crate for bananas, shipping, T. J. Lowther 690,657
Crushing mill, T. L. & T. J. Sturtevant 690,534
Cultivator, P. J. Nelson 690,758
Currycomb, S. B. Felty 690,712
Curtain fixture, M. Jolliffe 690,437
Curtain fixture, O. L. Schanbacher 690,881
Cutter. See Vegetable cutter.
Cutting apparatus, G. H. Peterson 690,767
Cutting mechanism, F. Herb 690,521
Cycle driving mechanism, J. W. Edblad 690,411
Cycle, motor, H. H. Peirce 690,602
Damper mechanism, time, S. S. Colt 690,637
Despatch tube, F. R. Taisey 690,675
Detergent and making same, Pease & McDonnell 690,458
Disinfecting compound, W. Martin 690,867
Disinfecting sewer vaults, apparatus for, W. Martin 690,866
Display box and support for neckties, J. H. Louder 690,864
Distilling apparatus, J. J. Roake 690,611
Distributing tank, K. G. Barkhausen 690,390
Ditch roller, S. D. McGuire 690,893
Door check, F. J. Miller 690,600
Door stop, W. V. Bleha 690,555
Drawing machine, railway head or other similar fiber, A. W. Mathewson 690,596
Dress shield, M. B. Gault 690,719
Drier, Trammell & McDuffie 690,796
Drill braces, attaching device for, J. F. Steckenreiter 690,669
Drill socket, O. A. Parpart 690,764
Drinking fountain for fowls, W. H. Busch 690,831
Dust collector tubes, support for, O. E. McMeans 690,455
Educational appliance, L. C. Levy 690,446
Educational appliance, W. A. Proctor 690,664
Electric machine regulator, dynamo, C. M. Green 690,420
Electric meter, G. H. Meeker 690,450
Electric motors or other electrical translating devices, controlling, G. T. Woods 690,807, 690,808
Electric motors or other electrical translating devices, apparatus for controlling, G. T. Woods 690,809, 690,810
Electric switches, independent operating means for, J. H. Spangler 690,787
Electric switch, E. R. Storm 690,479
Electric time switch, W. J. Carter 690,833
Elevator door, J. Mathews 690,749
Embossing and printing machine, P. V. Avril 690,822
Embossing machine, F. J. Albrecht 690,816
Engine, J. C. Bleyney 690,511
Engine boiler, G. E. Hesse 690,426
Engine shaft, J. L. Clayland 690,835
Engine speed regulator, explosive, A. L. Kull 690,443
Engines, draft generator for threshing machine, V. Stoltz 690,789
Envelop, return, T. C. West 690,500
Expansion joint, R. E. Vail 690,797
Explosive engine, F. D. Sweet 690,481
Extension table, J. Cornell 690,401
Feed roll, E. Ording 690,456
Feeder, automatic boiler, F. Leadbeater 690,445
Feeder or elevator, automatic, H. L. McCoy 690,891
Feeding machine, F. L. Cross 690,702
Fence, wire, C. T. Brown 690,514
Fiber from stalks, machine for separating, S. B. Allison 690,817
File, L. C. McNeal 690,869
Filter, C. S. Parker 690,457
Filter, E. M. Knight 690,524
Filter strainer, W. Wagner 690,541
Filter, water, W. Wagner 690,540
Firearm, automatic, Kjellman & Andersson 690,739
Fire extinguisher, J. H. Brittoon 690,556
Fire extinguisher, C. F. Brigham 690,633
Fireproof window, L. D. Biersach 690,392
Fireproof window, self-closing, F. D. Swaney 690,535
Fish trap, A. E. Zangenberg 690,507
Flash light lamp, photographic, J. L. Zweck 690,508
Floor and ceiling construction, J. Schratwieser 690,621
Floor construction, J. W. Rapp 690,609
Fly trap, Drake & Semple 690,566
Folding box, J. J. McCormick 690,454
Folding box, Z. B. Webb 690,496 to 690,498
Follower, hinged split, C. A. Batchelder 690,689
Foot warmer, J. T. Cole 690,836
Fountain. See Drinking fountain.
Fountain, F. W. Darlington 690,405
Fruit drier, W. A. Cates 690,834
Fruit or flower picker, T. Drynan 690,567
Fuel, manufacture of artificial, E. Springborn 690,888
Funnel attachment, W. A. Hesse 690,576
Furnace for burning bituminous coal, E. M. Hugentobler 690,431, 690,432
Gage, P. C. Smith 690,530
Galvanic battery, W. Erny 690,710
Galvanic battery or pile, Reed & Morrill 690,770
Game ball, W. H. Hoyt 690,861
Game device, E. Lasker 690,656
Garment supporter, E. W. Carter 690,635
Gas burner, W. J. Smart 690,471
Gas burner pressure regulator, automatic, C. A. Haas 690,573
Gas burners, mantle holder for incandescent, F. Quatram 690,606
Gas generator, acetylene, J. J. Hendler 690,425
Gas generator, acetylene, J. H. Ross 690,773
Gases, apparatus for cooling and cleaning blast furnace, B. H. Thwaite 690,795
Gasolene burner, W. C. Rand 690,608
Gate, W. R. Snyder 690,667
Gearing, frictional, G. Silvestri 690,884
Glass, etc., decorating, H. L. von Bonhorst 690,889
Glazing bar, D. J. Jarvis et al 690,732
Globe holder, G. Gray 690,419
Gluing machine, Fassett & Whittier 690,847
Gold separating machine, B. W. Sweet 690,791
Grading and ditching machine, W. H. Morenus 690,451
Grafting implement, D. A. Manuel 690,865
Grain binder, H. B. Sperry 690,477
Grain binding machine, M. Kane 690,439
Grain, drying, V. Lapp 690,592
Grass uprooter, D. N. Phillips 690,461
Grinding machine, drill, C. A. Chandler 690,398
Gun, automatic, A. Vickers 690,799
Gun cleaner, A. W. Bishop 690,393
Gun ejector, breakdown, E. H. Elder 690,568
Guncotton press, A. Hollings 690,728
Handle, Seybold & Mountford 690,622
Handle bar for cycles, etc., F. Sadler 690,464
Harness safety attachment, M. A. Dunn 690,642
Harrow tooth, A. H. Schaffer 690,776
Harvester, corn, V. Degenhard 690,841
Harvesting implement, celery, J. G. Smith 690,899
Hay elevator, J. Ney 690,660
Heating apparatus, J. A. Dezell 690,704
Heel cushion, shoe, L. Schwarz 690,779
Hexamethylentetramin and quinic acid and making same, salt of, Wichmann & Gabler 690,804
Hinge, J. G. Smith 690,782
Hitching or unhitching device, horse, S. McIntyre 690,892
Hoist, D. E. Rowland 690,774
Hoof pad, A. C. Tappe 690,482
Hook and eye, A. K. Phillips 690,528
Hook and eye, safety, T. Pedersen 690,765
Hopper for refining engines, C. Wurster 690,504
Hose member, W. C. Anderson 690,819
Hose terminal, H. E. McKechney 690,754
Hot water heater, F. Robbin 690,612
Hubs, machine for forming spoke holes in, E. Einfeldt 690,906
Hydraulic motor for pump and reversing valve therefor, W. O. Worth 690,813
Hydrocarbon engine, A. D. Richardson 690,610
Hydrogen sulfid, making, H. H. Wing 690,502
Ice cream freezer, J. A. Snigo 690,532
Ice pick, W. G. Browne 690,829
Ignition arch, J. P. Sneddon 690,473
Igniting plug, Davis & Mellen 690,640
Illuminating and heating burner, combination, V. K. Coffill 690,700
Incandescent lighting device, Hooker & Birchmore 690,578
Ink, copying, E. P. Lawton 690,862
Inkstand, L. I. Perry 690,766
Ink well, Dyer & Colhoun 690,643
Ink well, G. Doherty 690,843
Journal box and bearing, F. W. Thomas 690,483
Key holder, F. E. Brown 690,396
Key lock, changeable combination, W. H. Taylor 690,537
Knitting machine tension device, G. W. Ruth 690,775
Ladder, extension, P. Pirsch 690,462
Lamp glowers, making electric, M. W. Hanks 690,856
Lamp socket, J. C. Tourmier 690,487
Lath for plastering foundations, J. John 690,435
Lathe attachment for relieving the teeth of cutters, F. W. Parker 690,763
Laundry bag, G. H. Grant 690,854
Lawn sprinkler, H. Papenfus 690,762
Lead from lead ores, obtaining metallic, A. Germot 690,520
Leaf turner, W. J. Brashears 690,395
Leather stretching device, J. Caldwell 690,397
Linotype machine, P. T. Dodge 690,707
Liquid separator, centrifugal, P. M. Sharpless 690,883
Lock. See Key lock.
Locomotive ash pan, H. L. Browder 690,827
Locomotive springs, spring hanger for underhung, H. A. Gillis 690,851
Loom shedding mechanism, J. W. Platt 690,873
Loom shedding motion, W. C. Asimos 690,388
Loom warp stop motion, Coldwell & Gildard 690,636
Looms, electromechanical controlling mechanism for, J. C. Edwards 690,644
Luggage rack, H. Clark 690,699
Magnesium sulfite, making, H. H. Wing 690,503
Magneto-electric machine, Simms & Bosch 690,469
Mail marking machine, E. Cheshire, 690,695 to 690,697
Mat, A. Baumgarten 690,551
Match making machine, J. Dela Mar 690,905
Meat tenderer, R. Stone 690,533
Memorandum clip board, R. B. Dickey 690,842
Merchandise, system for distributing, R. O. Wickes 690,627
Metal and the manufacture thereof, covered strip of soft, I. W. Heysinger 690,427
Metal bars, rosette for forming crossed joints for, M. Mendel 690,598
Mixing machine, T. L. Smith 690,783
Molding machine, continuous, B. Fletcher 690,716
Mowing machines, means for adjusting finger bars of, W. D. Myers 690,452
Music cabinet, sheet, O. H. Stewart 690,478
Musical instrument, stringed, F. A. Porter 690,463
Nasal distender, W. Moores 690,527
Newspaper holder, J. Conzett 690,837
Noria, D. Hutton 690,584
Nut lock, P. S. Eklund 690,846
Nut lock, L. T. Stephenson 690,900
Nut lock, D. T. Wallace 690,902
Oil engine, internal combustion, H. F. Wallmann 690,542
Oils, apparatus for the vaporization, combustion, and utilization of hydrocarbon, T. Tomlinson 690,486
Organ, L. D. Hickman 690,726
Pail burner attachment, dinner, S. H. Cartrell 690,519
Paper box, folding, M. Herre 690,575
Paper, centrifugal sizing wood pulp or similar materiasl for the manufacture of, H. Schiller 690,777
Paper corrugating apparatus, J. T. Ferris 690,713
Paper drying machine, W. M. Barber 690,629
Paper making machine, C. H. Atkins 690,686
Paper marker, P. Grabler 690,853
Paper, paper pulp, and paper stock, machine for tearing up, C. Wurster 690,505
Phonograph or graphophone horn, J. W. Henderson 690,858
Photographs, pictures, etc., stand or frame for, W. Guttenberg 690,572
Piano action, L. N. Soper 690,784
Piano player, automatic, J. Sampere 690,618
Pile fabric, woven, A. F. McCollum 690,912
Pipe coupling, A. E. Dart 690,517
Piston lubricator, steam engine, J. C. Bleyney 690,510
Plaiting machine, E. W. Silsby 690,781
Pleasure device, W. R. Inshaw 690,434
Plow, W. R. Oyelr 690,761
Pneumatic despatch tube carrier, A. W. Pearsall 690,894
Poke, animal, B. F. Proffitt 690,875
Power transmission device, W. L. Judson 690,585
Power transmission mechanism, variable speed, W. L. Judson 690,586
Power transmission device, I. H. Davis 690,641
Powder cans, detachable spout for, L. J. Grove 690,571
Press. See Guncotton press.
Pressure regulator, automatic, A. S. Comstock 690,515
Printing carpets, mats, etc., apparatus for, A. F. Lundeberg 690,746
Printing films, adjustable holder for, J. A. Sauter 690,619
Printing machines, sheet delivery mechanism for, C. P. Cottrell 690,638
Printing press rolls, means for inking, J. H. Schussler 690,895
Propulsion, marine, J. J. Astor 690,821
Pulley, expansion, S. W. Wardwell 690,494
Pulping machine, C. Wurster 690,506
Pumping engine, steam, C. C. Worthington 690,545
Quinin salicylic ether, F. Hofman, reissue 11,960
Quoin lock, G. F. Peck 690,911
Rail joint, Hickman & Borrow 690,428
Rail tie and fastener, steel, J. S. McAwley 690,751
Railway cradle, marine, J. L. Crandall 690,402
Railway, electric, F. M. Ashley 690,386, 690,387
Railway, electric, G. Davis 690,406
Railway rail joint, F. Bain 690,823
Railway, single track, H. H. Teunis 690,539
Railway switch, E. B. Green 690,421
Railway system, electric, H. P. Wellman 690,499
Railway T-rails, grooved rail appliance for street, H. C. Phelps 690,603
Railway tie, J. P. Bickerstaff 690,691
Railway tie, steel, I. Dinger 690,705
Railway track and car truck, G. Meader 690,597
Railway track jack, Hale & Bartlett 690,423
Railway vehicle life guard, G. Kirby 690,738
Range boiler, A. C. Badger 690,628
Ratchet wrench, W. T. Garrett 690,647
Razor, safety, A. L. Silberstein 690,780
Register top plate, D. G. Clark 690,698
Rendering tank, W. C. Marshall 690,525
Request and mailing sheet, combined, D. L. Taylor 690,793
Rheostat for electric motors, starting, F. Mackintosh 690,448
Riveting machine, W. S. McKinney 690,755
Roasting pan, J. Herbs 690,574
Rock drill, A. C. Bates 690,630
Rock drill, A. M. Ballou 690,687
Rolls, cakes, etc., machine for making, M. Korth 690,741
Roofing material, F. S. Miller 690,526
Rotary engine, H. W. Van Auken 690,798
Sack holder, P. W. Erickson 690,412
Sash fastener, J. A. Kemp 690,440
Saw, L. R. Sosna 690,785
Saw, double cutting band, E. E. Thomas 690,678
Saw jointer and gage, combined, D. W. Solomon 690,668
Sawmils, haul up chain unloader for, E. E. Thomas 690,677
Sawmills, reciprocating lumber mover for, E. E. Thomas 690,679
Scale, C. G. Strubler 690,480
Scoop, H. H. Hodell 690,522
Screen frame, adjustable metallic, M. Messer 690,599
Seal, shackle, A. B. Schofield 690,466
Selector, K. Himrod et al 690,577
Sewing machine feeding mechanism, G. M. Todd 690,680
Sewing machine for felling, W. Arbetter 690,385
Sewing machine loop taker mechanism, W. Grothe 690,722
Sewing machine shuttle, V. Royle 690,616
Sewing machine stripper plate, R. G. Woodward 690,812
Sewing machine tucking guide, R. C. Johnson 690,735
Sewing machines, finger tip attachment for glove, L. A. Van Praag 690,682
Shade, W. A. Haywood 690,725
Shade roller bracket support, J. Renner 690,529
Show tray, T. S. Coffin 690,399
Sifting pulverized ores, etc., apparatus for, Jamieson & Odling 690,731
Sign, electrically illuminated, J. H. Goehst 690,649
Sign, street lamp, O. I. Terrell 690,901
Sink garbage holding attachment, C. E. Cox 690,838
Skate, O. W. Everett 690,711

(Continued on page 46)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ENGINE & FOOT LATHES. MACHINE SHOP OUTFITS. TOOLS AND SUPPLIES. CATALOGUE FREE. SEBASTIAN LATHE CO. 120 CULVERT ST. CINCINNATI, O.

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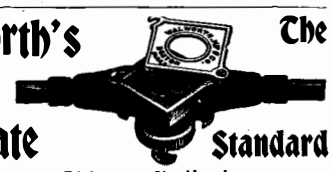
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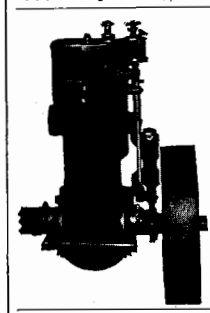
1999 Ruby Street, - - Rockford, Ill.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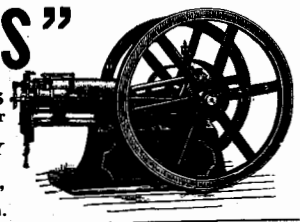
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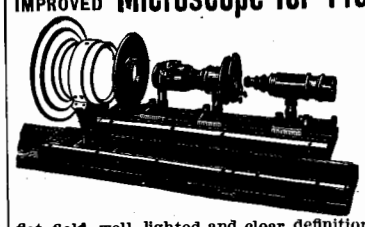
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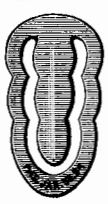
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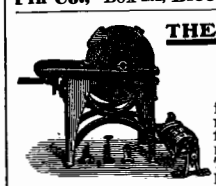
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Universal Keyboard.
Beautiful Work.
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THE SUN TYPEWRITER CO., 239 Broadway, New York.

As Others See Us

Every letter bears date November, 1901.

Defiance Machine Works, Defiance, O.
We have received orders from all over the world, through this advertisement, and we consider it the highest class advertising medium that is published in this country. It reaches every class of people that are interested in modern methods. It stands in such high favor with mechanics, that in most cases they have them bound, and after they are once put into book form, it gives the advertiser a standing ad. that lives indefinitely. Then, again, the Scientific American is sold by all the leading bookstores throughout this and foreign countries, and it is simply astonishing how far its influence reaches. We desire to state that we have been many times repaid for the money that we have paid you for advertising in the Scientific American.

Julian F. Denison, New Haven, Conn.
Our advertisement brought more intelligent and valuable inquiries than any other paper.

Winton Motor Carriage Co., Cleveland, Ohio.
The only publication in which we have advertised continuously. The reason is that results have been good at all times.

Williams Brothers, Ithaca, N. Y.
We are especially impressed by the wide field covered by your circulation, and value your journal as one of the most profitable mediums for advertising that we have ever been able to find.

J. B. Colt Co., New York.
The Scientific American is unquestionably a power of great influence in the commercial world.

William Roche, New York.
Results have not been exceeded by any other advertising we have done.

Eclipse Mfg. Co., Elmira, N. Y.
In number and quality the returns have been equal to those of any medium and far in advance of many of your competitors.

The Vilter Mfg. Co., Milwaukee, Wis.
A large proportion of the inquiries received came from parties who appeared to be in the market for our goods. We are well pleased.

Consolidated Engine-Stop Co., Waterbury, Conn.
We did not believe it possible to receive such large returns from such a small advertisement, from Boston to South Africa.

Wisconsin Wheel Works, Racine Junction, Wis.
Much pleased with the results, both in quantity and quality. Will use much larger space.

Buffalo Gasoline Motor Co., Buffalo, N. Y.
Have traced good share of our sales to the Scientific American, as all advertisements are keyed.

Watson McDaniel Co., Philadelphia, Pa.
Brought many inquiries from a new and valued field, heretofore not reached.

W. F. & John Barnes Co., Rockford, Ill.
Its readers are of the bright, studious, alert and interesting class and the inquiries mean business and are not from catalogue seekers.

Lowell Model Works, Lowell, Mass.
Consider the Scientific American to be an advertising medium of the first class.

Vulcan Iron Works Co., Toledo, O.
One of the best advertising mediums we know of. Have had a great many inquiries mentioning the Scientific American.

The Warren Co., Chicago, Ill.
The advertisement has paid for itself. One order from Russia, another from British Guiana, besides many inquiries.

Cyphers Incubator Co., Buffalo, N. Y.
No paper on our list yields a larger per cent of customers from the inquiries sent us. The readers of the Scientific American mean business when they send for catalogues.

Avery & Jenness Co., Chicago, Ill.
Inquiries from all over the world, as many as forty-five in one day. One of the very best mediums for advertising goods in the mechanical line.

Savage Arms Co., Utica, N. Y.
Results have been far ahead of expectations. Your paper will stand well at the head of the list. Advertising all keyed.

Neustadt-Perry Co., St. Louis, Mo.
Results beyond expectation. Inquiries coming in weeks after advertisements appeared, proving that your periodical is kept for continuous reference, which enhances its value.

C. A. Edgarton Mfg. Co., Shirley, Mass.
Results compare favorably with those obtained from such publications as Munsey's, McClure's, etc.

Merrell Mfg. Co., Toledo, O.
Received great benefit from the small advertisement.

Mead Cycle Co., Chicago, Ill.
Have kept record of all orders resulting from inquiries from each paper. On this basis, the Scientific American has shown very satisfactory results.

Standard Stamping Co., Buffalo, N. Y.
Have obtained very good results from our small advertisement, and recommend your paper as a good medium.

D. L. Holden, Philadelphia, Pa.
Some of the biggest contracts I have ever had came direct from the advertisements in your paper, not only in America, but foreign countries, as far away as China.

Niagara Falls Acetylene Gas Machine Co., Niagara Falls, N. Y.
We can truly say that we have received more benefit during the past four years than from any other advertising medium we have used.

Farr & Farr, Chicago, Ill.
The amount of inquiries that come in to us is astonishing; more than we ever expected.

Draper Mfg. Co., New York.
Inquiries and orders from various parts of the world resulting from our advertisement proves the wide circulation of your journal.

Turner Brass Works, Chicago, Ill.
Not only a large number of replies, but very satisfactory sales. Have rarely had any advertising pay as well.

Ohio Electric Works, Cleveland, O.
As an efficient advertising medium, it is unapproached. It is in a class by itself.

Motsinger Device Mfg. Co., Pendleton, Ind.
We have found no other paper which brings us as many inquiries.

Rhode Island Telephone & Electric Co., Providence, R. I.
Have had more inquiries than from any similar advertising in other papers, and from all parts of the world.

Sling lock trip, J. Ney	690,659
Smoke consuming device, J. H. Strehli	690,671
Smoke consuming furnace, G. S. & J. J. Huff	690,580
Smoke consuming furnace, J. J. & G. S. Huff	690,581
Smut machine, A. Coleman	690,565
Snap hook, combined bridle and halter, J. Candlish	690,832
Snow melter for railway switches, G. Kovacs	690,742
Soda fountain apparatus and syrup drawing can therefor, J. C. Johnson	690,436
Sparking coil, M. H. Moffett	690,750
Speaking tube terminal, J. O. Brown	690,557
Spinning or twisting frame, L. W. Campbell	690,694
Spinning or twisting machine, L. W. Campbell	690,634
Spring motors, automatic winding mechanism for, R. H. Sears	690,882
Sprinkler. See Lawn sprinkler.	
Stamp, time, C. S. Moseley	690,910
Steam boiler, B. F. Jackson	690,730
Steam plant drainage system, J. Angell	690,546
Steam separator, D. E. Austin	690,389
Steering gear, P. H. White	690,802
Stitch separating machine, J. B. Hadaway	690,422
Stoker, mechanical, G. S. & J. J. Huff	690,582
Stove, G. M. Cocke	690,564
Street sweeper, D. D. Hutchings	690,727
Striking bag, W. H. Price	690,605
Surgeons' use, sterilizer for, C. E. Norton	690,759
Swimmer's appliance, H. Pratt	690,663
Switch operating device, E. L. Pence	690,459
Switch operating mechanism, electric, Spangler & Herman	690,886
Tag, price, S. Dancyger	690,404
Tape holder, R. Sims	690,897
Telephone attachment, H. I. Hauxhurst	690,651
Telephone lines, service meter for, F. R. McBerty	690,453
Tenon cutting machine, D. Lynn	690,447
Thill support, J. H. Kessler	690,587
Thread cutting attachment for spools, J. F. Cordes	690,400
Threshing machine, J. A. Beam	690,690
Time recorder, S. Bower	690,394
Tire protector, pneumatic, C. G. Dinsmore	690,706
Tire, rubber vehicle, R. B. Price	690,604
Tire shrinking machine, cold, S. N. House	690,523
Tire, vehicle, W. M. Peck	690,872
Tire, vehicle wheel, J. Ludwig	690,908
Tires, composition for repairing bicycle, Campbell & Beam	690,903
Tires, device for automatically inflating pneumatic, G. O. Morris	690,601
Tobacco pipe cleaner, J. F. Forth	690,717
Toilet cream, J. C. Fleming	690,848
Tongs, W. Hopkie	690,860
Tool box, D. E. Frederiksen	690,414
Toy, C. Gordon	690,852
Toy, coin operated mechanical, F. Partsch	690,661
Toy savings bank, B. T. Wolf	690,544
Tracing and cutting implement, G. R. Vander Wee	690,489
Trap, R. G. McAuley	690,658
Traveler, A. Lonergan	690,594
Trees, apparatus for transplanting and transporting, J. M. Ralston	690,607
Trolley arms, sleet cleaning device for, M. M. Nash	690,757
Trolley, electric crane, M. A. Beck	690,553
Trolley harp, Crockett & Johnson	690,639
Trolley wire ice cutter, A. Ambuhl	690,818
Trowel, W. E. Coyan	690,839
Truck, J. A. Martin	690,449
Truck, car, S. A. Crone	690,403
Trunk, cleansing, F. H. L. James	690,652
Trunk for cotton or other pickers, cleansing, F. H. L. James	690,653, 690,654
Trunk or bale rope attachment, L. S. Ford	690,645
Truss, hernial, L. A. Smith	690,624
Tube boring out apparatus, J. Roan	690,878
Tubular boiler, W. B. McCord	690,752
Type casting and composing apparatus, H. J. S. Gilbert-Stringer	690,720
Type writer, C. E. Peterson	690,460
Type writer pad, R. E. Revalk	690,772
Type writing machine, R. J. Fisher	690,714, 690,715
Valve, cut-off, J. La Burt	690,743
Valve mechanism, air brake, E. G. Shortt	690,468
Valve, renewable seat, G. W. Walters	690,490
Valves for pumps, etc., arrangement of, F. W. Bogler	690,879
Vegetable cutter, H. Boos	690,512
Vehicle controlling mechanism, motor, J. F. McNutt	690,756
Vehicle, motor, W. J. Burt	690,830
Vehicle, motor, A. B. Fowler	690,849
Vehicle wheel, A. D. Smith	690,531
Vending machine, coin controlled liquid, O. E. Sorg	690,475
Vending machine, coin operated, C. L. Hurd	690,433
Vessel closure, metallic, R. B. King	690,441
Voting machine, A. J. Roth	690,880
Wagon bolster stake, A. B. Eisaman	690,845
Wagon brake, automatic, T. N. Black	690,509
Wagon lock, C. S. Dobbins	690,408
Waist, child's, F. A. Platz	690,768
Warp stop motion apparatus, J. A. Lamb	690,591
Washing machine, G. B. Dowswell	690,410
Washing Machine, O. L. Johnson	690,907
Washstand fixture, J. Barrett	690,550
Watchcase pendant, C. W. Butts	690,558
Watch stop, S. Goldfaden	690,721
Water fountain and cooler, sanitary, S. S. Shears	690,896
Waterproofing fabrics, J. Menzies	690,868
Wax from bituminous brown coal, manufacturing mineral, E. von Boyen	690,693
Weather Board marker, A. C. Maeder	690,595
Weather strip, G. W. Golden	690,417
Weather strip, C. W. Gautschi	690,648
Weighing and recording apparatus, Greene & Chisholm	690,855
Weighing machine, automatic, A. Arthur	690,820
Well tubing protector, oil, G. F. Tait	690,676
Wheel. See Vehicle wheel.	
Wick, lamp, E. S. Macfie	690,747
Wind power, apparatus for converting, storing and utilizing, P. F. Thede	690,794
Winding composite cops, machine for, S. W. Wardwell	690,492
Window platform, H. S. Howard	690,579
Window screen, adjustable metallic, T. J. Perrin	690,662
Wire crossings, hand machine for casting balls upon, J. Harris	690,723
Wire grip, W. C. Jones	690,438
Work conveying and presenting machanism, R. B. Fuller	690,416
Wrench, F. P. Bates	690,391
Wrench, F. W. Dent	690,407

DESIGNS.

Advertising puzzle sheet, C. E. Jaques	35,567
Belt, L. Sanders	35,570
Belt, B. Wilentshik	35,571
Bottle, K. Kiefer	35,558
Box opener, W. Hathaway	35,561
Burners, bowl for hydrocarbon, W. R. Jeavons	35,563
Corset, J. M. Van Orden	35,572
Drinking vessel, G. Forgach	35,557
Fan casing, A. L. Streeter	35,563, 35,564
Garment supporter, F. G. Dietz	35,548
Hose supporter, A. Hunter	35,549
Knife, butter, W. Hathaway	35,554
Life preserver body, H. A. Ayvad	35,550
Pail cover, J. S. Roblin	35,561
Parer frame, fruit, F. W. Belko	35,559
Plowshare lay, W. Gibson, Jr.	35,566
Shoe sole, J. S. Busky	35,569
Spectacles or eyeglasses, nosepiece for, I. Fox	35,551 to 35,553
Spoons, forks, or similar articles, handle for, C. A. Bennett	35,555
Spoons, forks, or similar articles, handle for, W. C. Codman	35,556
Trousers clasp securing bar, H. S. Brewington	35,547
Vehicle rub iron or fender, Dredge & Burke	35,567
Wall tie, R. Godfrey	35,565

TRADE MARKS.

Batteries and electric appliances, certain named, Manhattan Electric Supply Co.	37,629
Beer, United States Brewing Co., of Chicago	37,619

(Continued on page 47)

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Through the generosity of the founders of the School and of several prominent manufacturers, the Trustees are able to offer each year a limited number of

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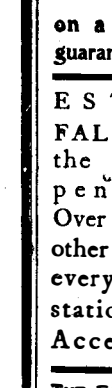

THE ESTERBROOK STEEL PEN CO
Works, Camden, N. J. 26 John Street, N. Y.

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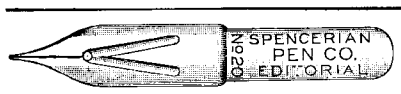

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SPENCERIAN PEN CO.

349 Broadway, New York.

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152 PURCHASE STREET, BOSTON, MASS.
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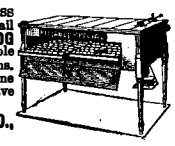

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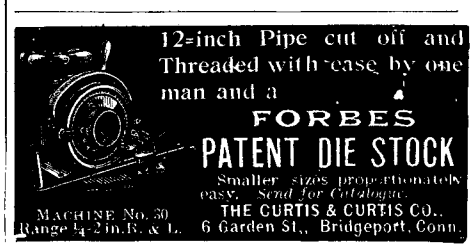
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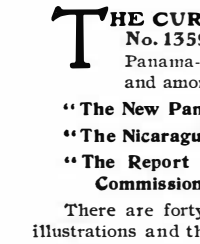

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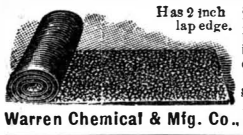

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(8500) E. O. M. writes: I have two textbooks on physics which disagree. Mr. Spottiswoode, of London, had an induction coil made which gave a 42-inch spark. One says it required 5 Grove cells to give the 42-inch spark; the other says 30 Grove cells were required. Which is right? A. The statement in Gordon's "Electricity" is that with five Grove cells the coil gave a spark 28 inches long; with 10 cells the spark was 35 inches, and with 30 cells it was 42½ inches long. 2. What difference of potential was required to force the spark across the gap of 42 inches? A. We do not know. Probably hundreds of thousands of volts.

(8501) J. C. A. asks: Please inform me how to make a strong magnet of Jessup steel. I have tried to make some ½ inch square by 3 inches long, straight bars, by passing them through a spool of wire with a 300-volt current, by which they were strongly magnetized, but lost almost all magnetism in about three weeks. How can I make such magnets which will retain their strength for a long time? A. Heat the bars to be magnetized to a red heat and plunge them into water. They are then to be magnetized. Straight bars do not retain magnetism well. They should lie in pairs with opposite poles toward each other, side by side, not end to end, or else in pairs with an iron keeper across the poles. They may be laid four in a square with opposite poles against each other. Laid down alone without keepers, the magnetism is rapidly lost.

(8502) S. S. asks: Please tell me whether there is any such thing as an absolute vacuum, and if so, how is it produced? A. It is claimed that an absolute vacuum has been made by chemical means. The gas remaining after exhaustion had been carried as far as possible by means of pumps, was absorbed by chemicals and the space was then empty of gas, a vacuum. Another method has been described. Fill a hard glass tube closed at one end with soft glass. This on solidifying presents the appearance of a glass rod, solid throughout. When this is connected to an air pump and heated so that the soft glass melts, the melted glass will drop from the top of the tube, just as the mercury does in the barometer and Torricellian experiment. Upon cooling the soft glass solidifies again, leaving a complete vacuum in the upper part of the tube.

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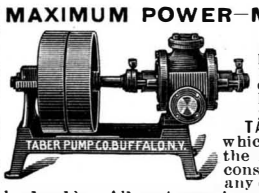

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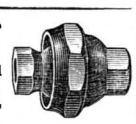

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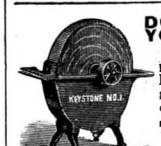

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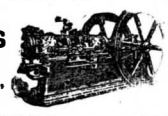

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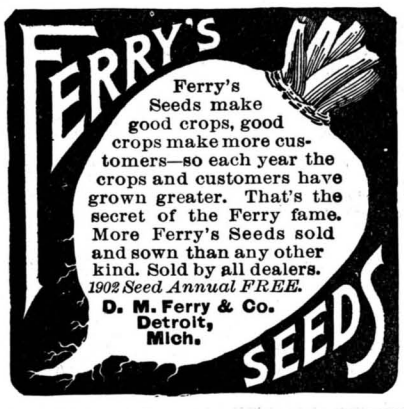
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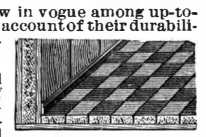

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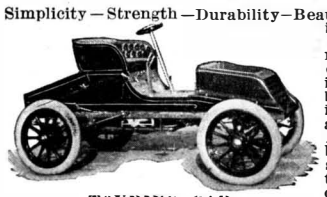

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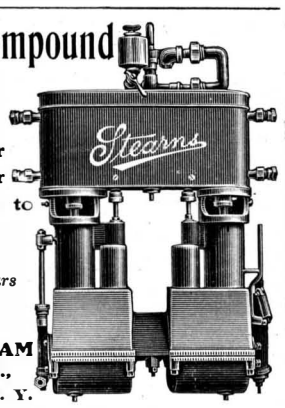

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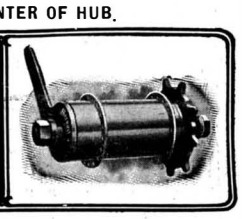

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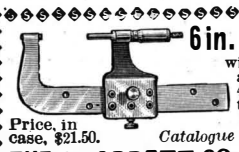

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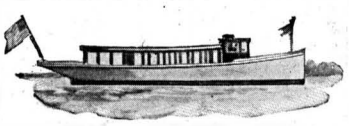

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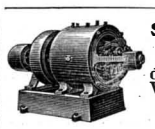

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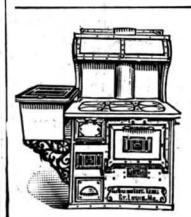

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